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Chicago's Newest Cold Storage

NEW TYPE AMMONIA COMPRESSORS AND SYSTEM OF COOLING LIQUID AMMONIA ARE SPECIAL FEATURES

WITH ITS GREAT WALLS eleven stories high resembling rows of blank panels crowned with a row of windows and its massive corners, the new cold storage building of the Chicago Cold Storage & Warehouse Co., at 16th and State Sts., presents an imposing sight emblematic of Chicago, the storehouse of the North and the West. This building is advantageously located next to the tracks of the Illinois Central Railroad and near other railway terminals, as well as near the center of the city which reduces to a minimum the expense of handling products by trucks. In the building is a cold storage space of 4,000,000 cu. ft., which requires 600 tons of refrigeration per day in summer weather. Two complete floors, the 10th and 11th, are occupied by the Fox River Butter Co. for making and storing butter, while other rooms are also used by this company for offices and other purposes.

The building and equipment are designed for storing such products as meat, poultry, butter and eggs, with facilities for rapid handling between cars or trucks and storage rooms. As will be noted from the illustrations, the power plant is not quite complete, but a great share of the storage space is already occupied and all machinery is in operating condition.

GENERATING STEAM

STEAM FOR operating the compressors, generating engine and pumps is furnished by three 325-hp. Stirling boilers at 175 lb. pressure and 100 deg. F. superheat.

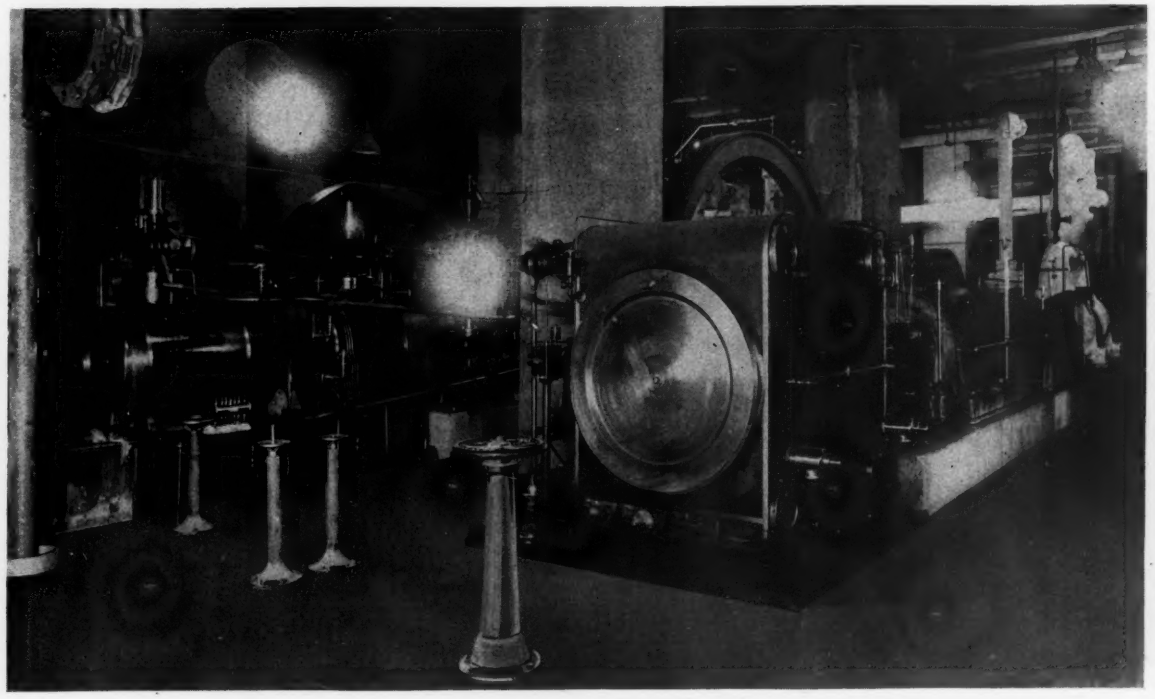


FIG. 1. VIEW IN THE COMPRESSOR ROOM

These are served by Babcock & Wilcox chain grate stokers placed in furnaces of the semi-dutch oven style with a higher arch over the rear of the grate, which deflects the gases of combustion towards the boiler tubes of the first pass and insures complete combustion before the gases strike the heating surfaces. The stokers are run by eccentric rods from an overhead line shaft which in turn is driven by belt from one of two Troy engines placed on a foundation, bringing the engines level with the line shaft.

Coal comes to the plant in drop-bottom cars and is dumped by gravity through stoke holes into the coal bins directly in front of the boilers and on a level with the boiler room floor. From here it is shoveled by hand into the stoker hoppers. Unburned coal and coke that drops through the fore part of the grate into the shallow pit is drawn forward and shoveled back into the hopper. The ash going over the end of the grate falls into the pit and is scraped forward into the entrance funnel of the Hofft steam-vacuum ash conveyor which delivers it to a bin on the third floor where it is sprinkled to prevent dust from going to the stack through the vent pipe. The bin is located directly over the railroad tracks and the ashes are discharged by gravity to cars as required for disposal.

Feed water is principally condensate from the surface condensers and is further heated in an Angell open feed-water heater; makeup water is taken from the warm condensing water before it goes to the cooling tower.

Two Burnham boiler feed pumps of the simplex plunger type deliver the water from the heater to the boilers; the sizes of the pumps are 12 by 7 by 12 in. and 12 by 8 by 16 in.

Ammonia Compressors

Three Vilter ammonia compressors are installed: one of these is a standard type double-acting duplex compressor, each cylinder being 17½ by 34 in., the steam end is a cross-compound condensing engine, the high-pressure cylinder being of the poppet valve type 20 by 34 in. and the low-pressure cylinder 40 by 34 in. with Corliss valves. This machine is intended for high temperature work and is rated at 200 tons of refrigeration.

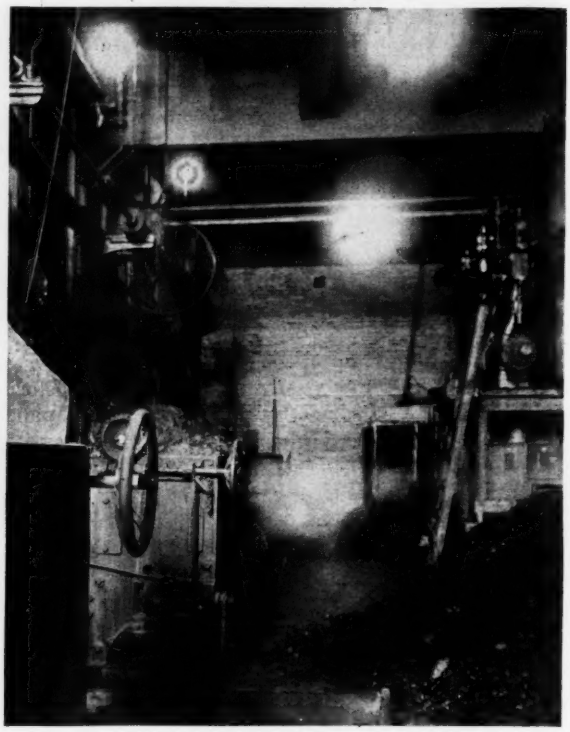


FIG. 3. WHERE THE FIRST STEPS IN REFRIGERATION START

For low temperature work two two-stage compressors are installed. The low-pressure ammonia cylinders are 24 by 48 in., and the high-pressure 19 by 48 in., each connected to cross compound steam engines 20 and 40 by 48 in. with poppet valves on the high-pressure and

FIG. 2. EXTERIOR VIEW OF THE CHICAGO COLD STORAGE & WAREHOUSE CO.'S NEW PLANT

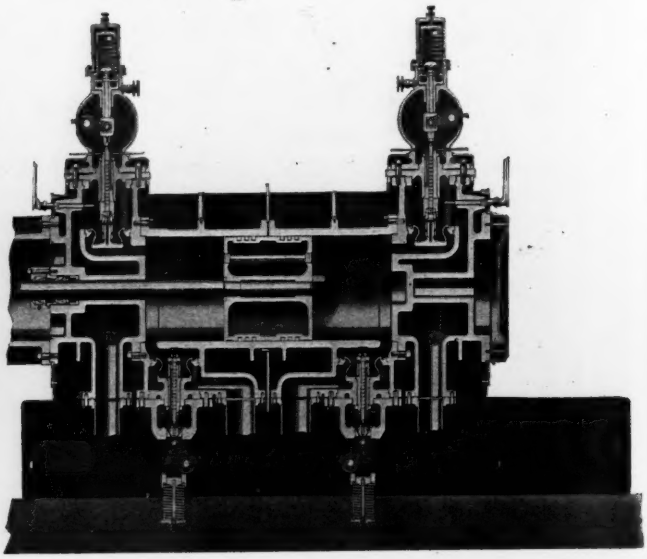


FIG. 6. CROSS-SECTION OF POPPET-VALVE CYLINDER

Corliss valves on low-pressure cylinders. These machines are so connected that the discharge from the two low-pressure cylinders of the two-stage compressors enters the common header which is the suction header for the standard duplex machine as well as for the high-pressure cylinder of the two-stage compressor.

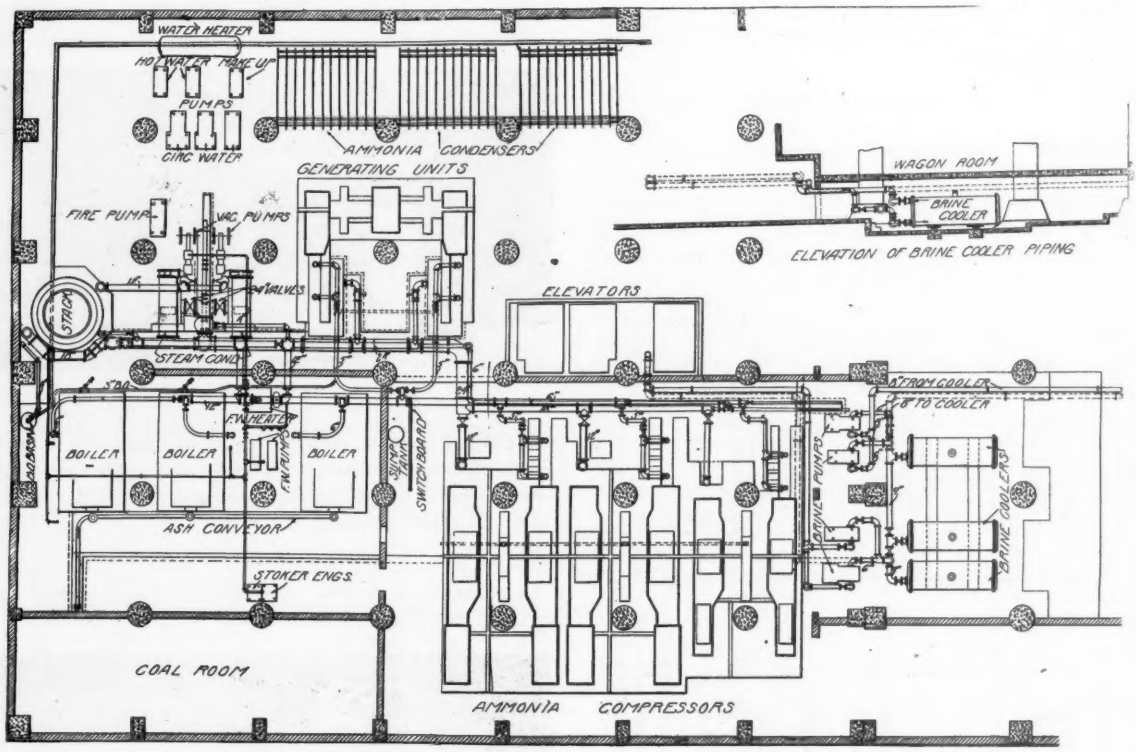


FIG. 4. PLAN OF FOUNDATIONS AND STEAM AND EXHAUST PIPING

These engines represent a new design of the Vilter Mfg. Co. for medium speed of the poppet valve type for use with high-pressure, superheated steam, which possess many novel features. The remarkable economy of these engines is due to the use of superheated steam, which eliminates cylinder condensation waste, enables the more efficient use of the steam itself and does away with the minor wastes due to radiation, etc.

One of the leading features is that the valve gear is operated through wristplates driven from eccentrics placed on the engine shaft, as opposed to the type employing a lay shaft. The steam and exhaust valves are of the double seated poppet type, mounted in cages inserted in suitable housings in the heads and cylinder. The valve seats are not a part of the head and cylinder proper, but are in the housings and are of such design that the valves may easily be kept tight regardless of the action of heat on the machine. The valve stems are exceptionally long, being ground into the guides, and no packing is used. The stems are provided with labyrinth grooves which form a series of chambers in which any escaping steam is condensed, making them perfectly steam tight. Each valve stem is lubricated by means of force feed lubrication, ample provision also being made for drainage of excess moisture and oil.

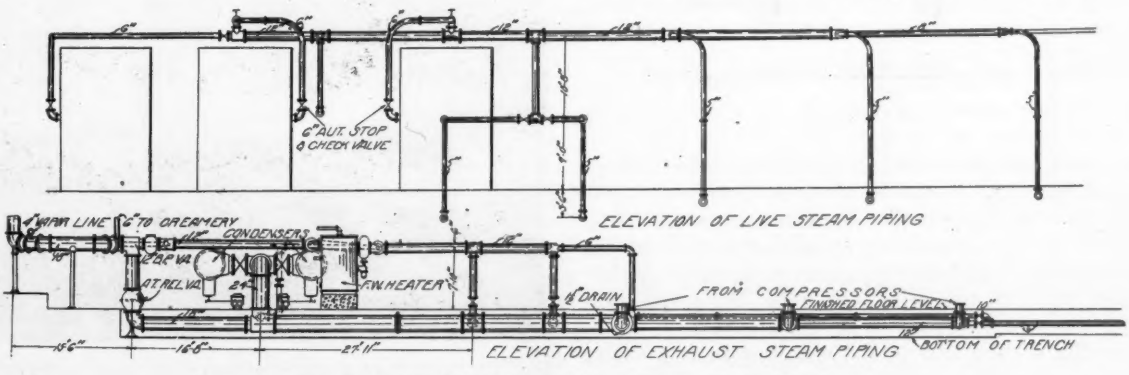


FIG. 5. ELEVATIONS OF STEAM AND EXHAUST PIPING

The action of the entire valve motion is analogous to that of the valve motion of the ordinary Corliss engine.

The cylinder heads, containing the admission valves, are steam jacketed, thereby keeping the heads of the cylinder at high temperature and preventing condensation during the cycle of operation.

The cylinder is lubricated in three different places by force feed lubrication, the oil feed pipes being inserted directly into the cylinder walls in such a manner that the oil is properly distributed around the walls of the cylinder as required.

The Ammonia Cycle

From the compressors, the ammonia gas passes through an oil separator to the ammonia condensers of which there are three, each consisting of 12 stands of double pipe, 2 and 3-in., 12 pipes high and 19 ft. long. The condensed ammonia drains to a receiver from which

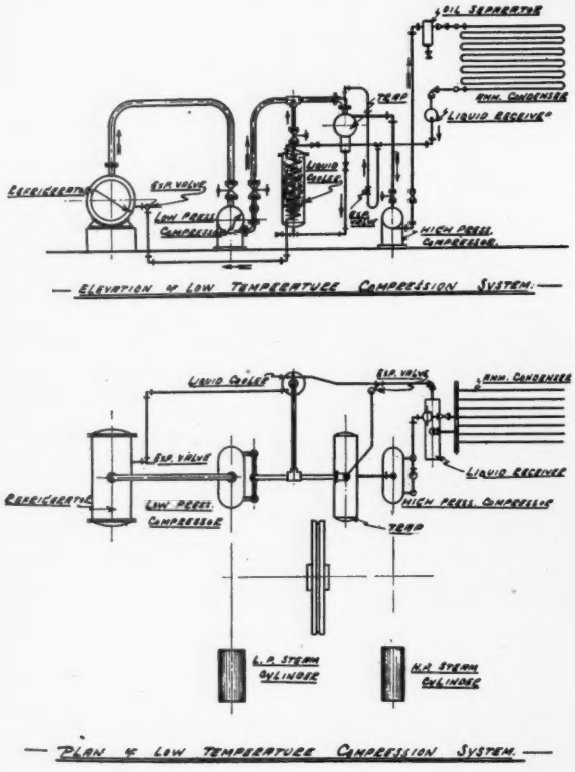


FIG. 7. DIAGRAMMATIC ARRANGEMENT OF AMMONIA PIPING

it is piped through a liquid cooler to the brine coolers. All refrigerating in the building is done with brine coils, the brine being cooled in three coolers, two being used for the low temperature rooms and one for the egg compartments. In addition, however, ammonia is furnished for a 35-ton brine cooler on the tenth floor, which is occupied by the Fox River Butter Co.

In the suction line to the compressors is a fitting called a spider which has the form of a cross, its function being to remove any liquid ammonia which may be carried along with the gas and deliver it to an ammonia liquid cooler. The gasified ammonia passes to the compressors while the cooled liquid passing through a coil goes to the brine coolers. The principle employed here is the same as in a flooded system.

Calcium brine is the medium used for conveying the heat from the rooms and is cooled to a temperature of 16 deg. below zero F. in three brine coolers of the horizontal cylindrical type, each being rated at 200 tons of refrigeration per day.

For circulating the brine, four pumps are used; two of these are American-Kerr turbo-driven centrifugal pumps, while the other two are American Well Works

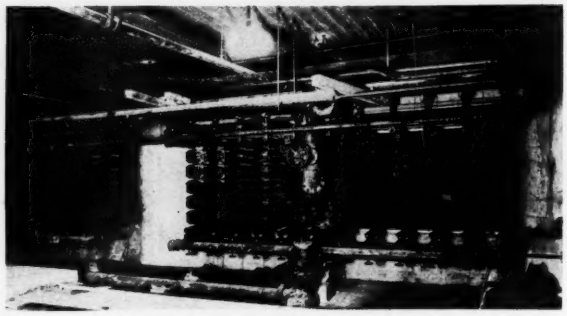


FIG. 8. VIEW OF AMMONIA CONDENSERS

centrifugal pumps driven by Allis-Chalmers motors. These pumps are cross connected in such a way that they can be used interchangeably and have sufficient capacity that one is held in reserve.

Cooling Water System

Circulating water for the condensers passes first through the ammonia condensers where it is raised in

FIG. 10. FREEZING BEEF, TEMPERATURE ZERO, A TYPICAL VIEW

temperature to 80 or 85 deg. F. (26 or 29 deg. C.), then through the steam condensers where it reaches 120 deg. F. (49 deg. C.), and is then delivered to the cooling tower which is 125 ft. long, 12 ft. wide at the top, and 45 ft. high, and is located on the roof of the building.

Here the water is cooled to 3 or 4 deg. below atmospheric temperature. After dripping over the cooling baffles, the water falls to a tank from which it flows by gravity through the condensers again. For circulating the water, three American centrifugal pumps are employed, two of which are driven by motors, the other by a Kerr turbine.

The ammonia compressors and generating engines are run condensing, the exhaust steam being delivered to two Worthington surface condensers, each having 1200 sq. ft. of condensing surface. The condensate is removed by two wet vacuum pumps and delivered to the feed-water heater and the noncondensible vapors are handled by two 7 by 14 by 8-in. Blake & Knowles flywheel type dry vacuum pumps. Piping is so arranged that the steam can be bypassed around the condensers to the atmosphere and the condensers are provided with a Davis atmospheric relief valve.

Electricity for running the motors and furnishing light is supplied by two generating units consisting of Vilter poppet valve engines, 20 by 22 in., run condensing direct connected to Allis-Chalmers d.c. generators rated at 200 kw. each, furnishing current at 250 v.

A dry type sprinkler system is installed throughout the building with 16 trip valves, eight of which are in the engine room; the pressure is maintained at 80 lb. in the basement by a gravity tank on the roof. The fire pump is of the duplex type, 18 by 10 by 12 in., made by the Barr Pumping Engine Co. It takes water direct from the city mains and has a delivery pressure of 160 lb. on the system.

In the building are six freight and one passenger elevators, all of which are electrically driven and, with the exception of one Otis freight elevator, were manufactured by Kaestner & Hecht. In addition to the elevators, a spiral chute is installed which permits products to be transferred rapidly from cars to cool space. This chute extends from the unloading platform to the basement.

In the general plan of the building, the cooling rooms are in the east end and are maintained at about 30½ deg. F. for storing eggs. The low temperature rooms are on the west end and the temperature is kept at from 0 to —10 deg. F. for storing meat, poultry and butter.

Insulation of the walls consists of a 6-in. thickness of cork, the floors are covered with 3 to 6 in. of cork, while the ceiling of the top floor has a 5-in. layer of cork. Insulation for the brine pipes is also of cork, being made up of 2 layers 3 in. thick.

The ratio of pipe length in feet to cubic feet of space in the egg rooms is about 1 to 15, while in the low temperature rooms it is 1 to 5.

Westerlin & Campbell Co. did the contract work of installing the refrigerating machinery, which is the product of the Vilter Mfg. Co., and we are indebted to them and to F. F. Sherwood, superintendent of power in charge, for information given in this description. G. G. Fee is the chief engineer of the plant.

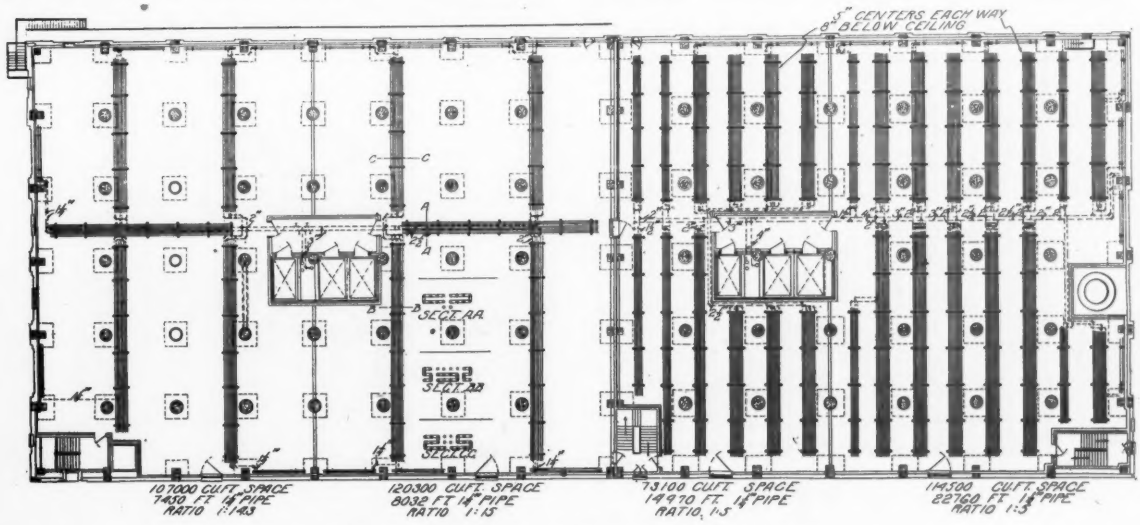

8" CENTERS EACH WAY 8" BELOW CEILING
SECT. AA
SECT. BB
SECT. CC
107000 CU.FT. SPACE 7450 FT. 1¼" PIPE RATIO 1:14.3
120300 CU.FT. SPACE 8032 FT. 1¼" PIPE RATIO 1:15
73100 CU.FT. SPACE 14970 FT. 1¼" PIPE RATIO 1:5
114500 CU.FT. SPACE 22760 FT. 1¼" PIPE RATIO 1:3

FIG. 9. TYPICAL PIPING OF REFRIGERATING ROOMS

THOMAS E. DURBAN, for more than 27 yr. with the Erie City Iron Works, Erie, Pa., has severed his connection with that firm. For the present he does not intend to engage actively in business. He has, however, taken a suite of offices in the Commercial Bldg., Erie, Pa., where as chairman of the Administrative Council of the American Uniform Boiler Law Society he will devote his entire time and attention to the promotion of the A. S. M. E. Boiler Code, which has already been legally adopted in a number of states. Communications intended for him should be addressed to his Erie offices in the Commerce Bldg.

THE FRENCH government is taking control of the products of the mines and all imports, apportioning them among munition works, railroads, manufactories and the civil population in proportion to their value to the government and their necessity. Speculators have demanded from $60 to $80 per ton.—Chicago Commerce.

IT IS RUMORED in London that a scheme is being elaborated to bring the whole electric power industry of Great Britain into a monopoly.—Chicago Commerce.

European Experiences with Stirling Boilers

DETAILS CONCERNING THEIR MANUFACTURE AND OPERATION. BY B. N. BROIDO

STIRLING boilers as first introduced into Europe were built the same as the Stirling boilers in this country, but the design was gradually changed following improvements, which resulted from tests and experience, to suit better the conditions in that field. Boilers mostly used are of the 3, 4 and 5-drum type, the 2-drum type being used only for very small boilers and low capacities, because this type, as is the case with most 2-drum types of vertical tube boilers, delivers wet steam, when operated at high capacity.

Attempt was made with a new 5-drum boiler, Fig. 1, to eliminate the radiation through the front wall and a boiler of this type was designed by the writer. Tests showed that this type of boiler is worth the extra expense, on account of less radiation, especially at power plants where fuel costs are high.

Drums for all sizes of boilers to 8000 sq. ft. of heating surface are made of one broad sheet of steel, thus having no girth seams, except those connecting the heads with the shell. Longitudinal joints are located so that they do not come in contact with the flue gases.

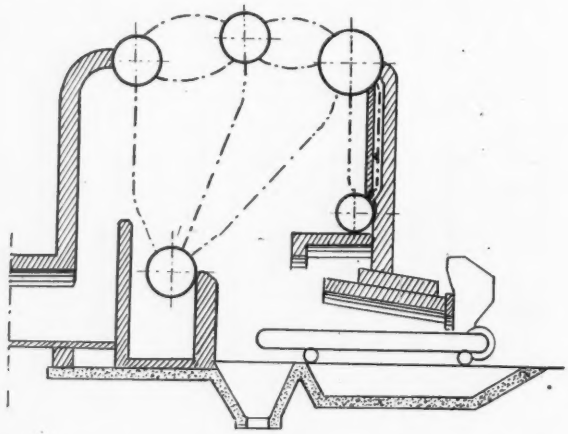


FIG. 1. STIRLING BOILER DESIGNED TO REDUCE FRONT WALL RADIATION

All longitudinal joints are welded, the process consisting of heating the plates from both sides with water gas, and uniformly hammering to secure the weld.

Water gas with which the welding operation is accomplished, has a composition of approximately 3 per cent CO_2, 45 per cent CO, 5 to 6 per cent H, and about 3 per cent N. The combustion of this gas mixed with air in a proportion of about 5 vol. of air to 2 vol. of gas produces a temperature of 3300 to 3500 deg. F. After welding, the seam is carefully and uniformly annealed.

Test specimens taken from drums welded in this manner have shown a tensile strength from 50,500 to 57,000 lb. per sq. in., and an elongation from 25.5 to 33 per cent, almost the same as given by the original sheet. Drums thus fabricated are used on boilers with 370 lb. steam pressure. The heads are spherical in shape and one on each drum is provided with a manhole.

SPECIAL DESIGN OF STIRLING BOILER

FIGURE 2 shows the characteristic disposition of boiler tubes in a 4-drum boiler designed by the writer, which has 3800 sq. ft. of boiler, 650 sq. ft. of superheater, and 1900 sq. ft. of economizer heating surface. This boiler can be operated with coal, or coke oven gas, or both, at peak loads.

Each tube of the boiler is bent to the same radius, and ordinarily about 30 in. was found best, allowing the pipes sufficient flexibility to follow the stress which takes place, and affording an easy passage for a cleaning tool through the tube. It is customary to furnish with each boiler, a bench on which tubes can be bent cold and without filling. Figure 4 shows the bench and how the pipes are bent. Tube ends are made metallically clean and expanded in the drum on the job, giving joints that are quite reliable.

In order to determine the resistance of an expanded joint against the sliding of the tube a number of tests were made with different methods of expanding. The results are given in Table I. At a steam pressure of 350 lb. per sq. in. the total pressure on the cross-section area of a pipe 3 in. outside diameter, is about 3110 lb. The table shows that the factor of safety of the simplest expanded joint No. 1 is over 5, while with each of the other types, Nos. 2 to 6, it is more than 10. These tests also prove the reliability of the expanded joint for piping.

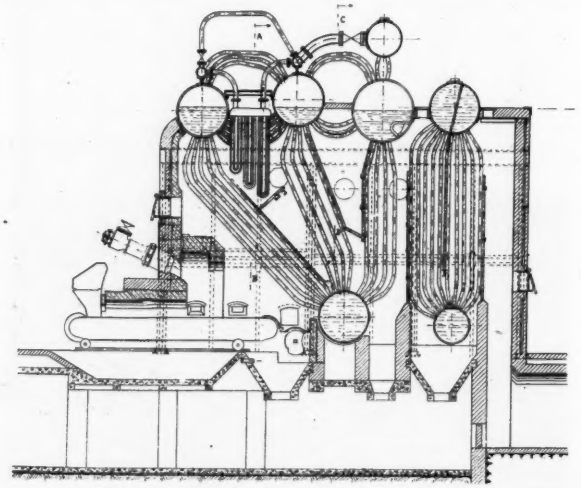


FIG. 2. SPECIAL EUROPEAN DESIGN OF STIRLING BOILER WHICH INCLUDES ECONOMIZER

Upper drums rest on a steel scaffolding which also serves as a frame for the setting, and the lower drum and the tubes are suspended from the upper drums. This gives the boiler great flexibility, as each tube can expand individually. With this particular design, the feeding of cold water is not dangerous, and it is possible to fire the boiler up to full pressure quickly, and to force it to a high capacity in order to follow peak loads without causing leakage of the boiler.

By providing a solid wall of fire brick, the lower drum is isolated from the fire chamber, thus keeping it

comparatively cool, and as the mud inside the drums does not burn and adhere to the walls, it can be easily removed.

Bow Settings for Stirling Boilers

Settings of Stirling boilers in Germany, almost without exception, are of the bow system, shown in Fig. 3. These settings are more flexible, and can better withstand the temperature variations on both sides than the straight settings, as it is evident that the outside bow can better follow the expansion of the wall toward the boiler, than a straight wall. One seldom finds a cracked bow setting. Due to the fact that a convex surface reflects more heat than a flat one, the radiation of the bow setting is considerably less than that of a regular setting.

Figure 2 shows also the superheater with its large number of suspended "U" bends of ½-in. pipe, the ends of which are welded to the bottom of a cup header.

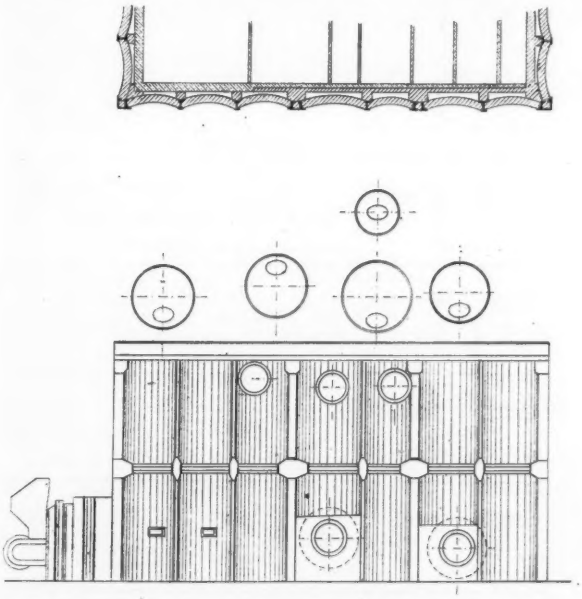


FIG. 3. SPECIAL BOW SETTING FOR STIRLING BOILER

Generating, distributing and receiving of heat in the special Stirling boiler are, of course, the same as in the Stirling boiler in this country. As the temperature of the gases is high, the heat transmission at the front bank of boiler tubes is very high. Temperature of the gases depends, of course, upon the excess air. Tests with coal of about 1300 B.t.u. per lb. have shown the following temperatures: With CO_2 contents of 8, 10, 12 and 14 per cent, the temperature of gases entering the front bank of the boiler tubes was 1880, 2280, 2675 and 2860 deg. F. Moreover, the absorption of heat is affected by the intense radiation from the large grate surface and the fire brick arches, so that the first part of the boiler generates from 60 to 80 per cent of the entire quantity of steam.

Although the flue gas enters the superheater chamber with a considerably lower temperature, it is sufficiently high to superheat the steam 300 to 375 deg. F., a superheat which is frequently used in Europe for the modern turbines and engines. From the superheater the gases pass over to the second and third banks of tubes, where the remainder of the steam is generated. Leaving the boiler heating surface with a temperature from 400 to 700 deg. F., the gases usually transfer an additional part of their heat to the feed water in passing through a flue gas heater or economizer.

Circulation of Boiler Water

Feed water enters the rear upper drum, which is large enough to allow the water to remain a sufficient length of time to become heated and give up a considerable part of its scale-forming substances before entering the tubes, the precipitate being a flaky mud, which can be drawn off through the blowoff valve. After being relieved of most of its scale, the feed water slowly descends the rear bank of tubes, which being vertical, do not permit an accumulation of scale on the tube walls, and as the temperature of flue gases here is low, there is no possibility of the scale burning on the tubes. Passing through the tubes the feed water becomes further heated and precipitates the remainder of the impurities when passing through the lower drum. The slow velocity of the water, and change of flow before entering the

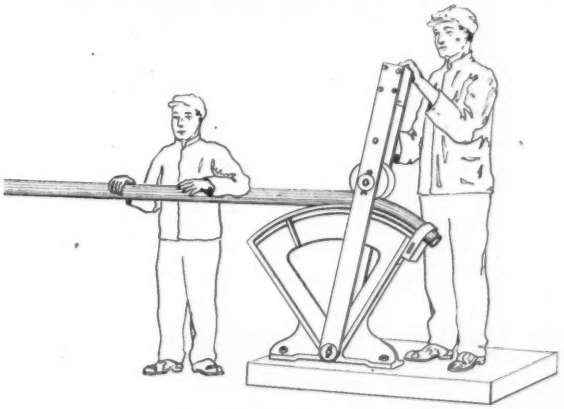


FIG. 4. BENCH FOR BENDING TUBES

other banks of tubes causes the scale to separate out and accumulate in the mud drum.

Free from scale, the water divides into 2 currents and enters the front and center banks of tubes, the main current flowing through the front bank, where, as already mentioned, the greatest part of steam is generated. Here the water becomes highly saturated with steam particles, consequently a light water-steam mixture is formed, which ascends with great velocity to the upper drum.

On account of the rapid generation of steam in the first bank of tubes, the water level in the front drum is agitated, and is generally known to be higher than in the middle drum. If steam were taken from the front drum, it would be very moist, especially when the load on the boiler is subject to quick changes or is extremely high.

Flowing through the center bank of tubes to the middle drum, the second current carries considerably less steam and its velocity is correspondingly lower. Therefore, the water level in this drum is steadier, and lower than the level in the front drum. Steam taken from this drum carries much less moisture.

Arriving at the front drum, the main current gives up the steam and flows with low velocity through a num-

ber of pipes to the middle drum, where it combines with the second current, and passes through a large number of tubes spread over the entire length of the drum to the rear drum. Here it mixes with fresh incoming feed water, and starts again on its circuit through the boiler.

SPECIAL STEAM HEADER TO SECURE DRY STEAM

STEAM TAKEN from the front drum is quite moist, especially when the boiler is overloaded or carries a variable load; and in order to separate this moisture, the steam is conducted through the following course, which differs slightly from that of the Stirling boiler, as it is built in this country.

From the highest point of the front drum the steam is delivered with low velocity to the middle drum, where it combines with the incoming steam from the center

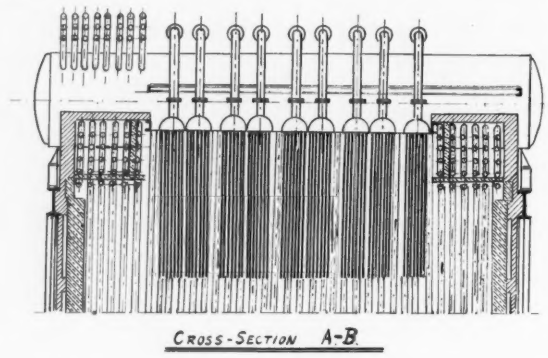


FIG. 5. CROSS-SECTION A-B OF SPECIAL BOILER

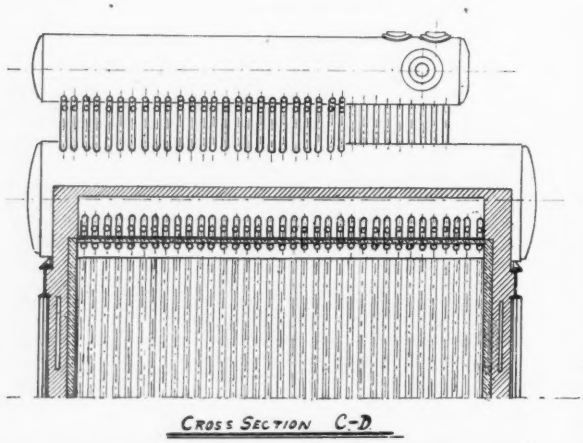


FIG. 6. CROSS-SECTION C-D OF SPECIAL BOILER

bank. This drum has the steadiest water level, and as the water descends only, the drum serves as an ideal separator. Steam up to an evaporation of 7 lb. per sq. ft. heating surface is practically dry.

When boilers were to be operated with extremely changeable or high loads we added a steam header, which was connected with the rear drum by a large number of pipes of the same size and curve as the ordinary boiler tubes. In these tubes the velocity is very low, so that dry steam is always secured.

Of great importance for good operation of the boiler are the number and arrangement of connecting tubes between the drums for both water and steam. Figures 5 and 6, which are respectively cross sections A-B and C-D of Fig. 2, show the arrangement of the tubes for this special boiler.

When the boiler carries a high load, the circulation in the first bank of tubes is very rapid and a large amount of water flows with the steam into the front drum. A sufficient number of tubes must be provided to carry away this water to the middle and rear drums, in order that the water level in the front drum may not rise too high, diminishing the steam space and causing water to be driven off with the steam; the velocity in the steam connection tubes must, for the same reason, be low.

In order for every owner or operator of a Stirling boiler to determine whether his boiler is properly de-

Kind of Expanding	O. D. of Tubes	Required force to remove pipe	Remarks
1	3-5/16 in.	15,200 lb.	
2	3-5/16 in. (4 in.)	30,300 lb. (43,600 lb.)	13000 lb. Continuous pull was necessary to draw the pipe from plate after its original position was changed. (18500 lb.)
3	3-5/16 in.	38,500 lb.	Only after the plate became considerably bent did the pipe start to move.
4	3-5/16 in.	56,200 lb.	15000 to 11000 lb. Continuous pull necessary to draw the pipe from the plate after its original position was changed.
5	3-5/16 in.	54,600 lb.	
6	3-5/16	28,100 lb.	11000 lb. Continuous pull necessary to draw the pipe from the plate after its original position was changed.
7	3-5/16 in.	14,350 lb.	

TABLE I. RESISTANCE OF EXPANDED JOINTS

signed in this respect, the following data may be of assistance:

One water connection tube between the front and center drums should be provided for every 400 lb. of steam up to the rated capacity of the boiler, and one tube between the center and rear drums for every 300 lb. The velocity in the steam connection tubes between the first two drums, when the boiler is operated at its rated capacity, must be not more than 1000 ft. per min., assuming that the first bank of tubes generates 75 per cent of the entire steam. Velocities in the tubes between the center and rear drums, and between the rear drums and the steam header, are 700 and 500 ft. per min. respectively.

It may be proper here to mention that foaming and priming of a boiler, is not always the fault of the boiler

design, for the concentration of alkali salts in the water within the boiler often causes foaming and priming. Organic matter, loosened scale, or lubricating oil may also cause the water to foam.

Many waters, not naturally foaming as they come from their source, can be made so by concentration. When a boiler is seldom blown down, the evaporated water leaves the foaming constituents in greater strength. Hence, the boiler must be often blown down to remove a portion of the concentrated foaming constituents. Admitting fresh water will dilute that which remains in the boiler to a point where it will not foam.

Often an excess of soda-ash was found to be the reason of foaming in the boiler. Frequent blowing off will help eliminate the trouble in these cases.

An important feature of the Stirling boiler is the fire brick arch over the furnace. Its design depends upon the kind of fuel used, and the capacity of the boiler. In general, it was found that the grate should not be set flush front, but should be extended sufficiently to the front of the boiler to give a good igniting action. Usually for a 4-drum boiler, which will not be heavily overloaded, and for average good coal, an ignition arch about 5 ft. long gave good results. The distance between grate and arch at the front was, for the above conditions, usually made 12 in. and a distance of about 20 in. was allowed at the end toward the boiler tubes to provide more space for combustion.

Especially for boilers which are frequently overloaded, the grate should not be too short. On high loads the short grate will smoke badly, on account of the thick coal bed, and a portion of coal will reach the end of the grate and fall into the ashpit unburned.

Scale in the front bank of tubes not only diminishes the efficiency of the boiler, but also often causes tube defects. In order to assist in preventing the scale from being carried to the front bank of tubes, we provided the mud drum, particularly with boilers which are fed with hard or muddy water, with a baffle plate.

Reinforcing Manholes in Steam Boilers

DETAILS OF METHODS EMPLOYED AND CALCULATION OF REINFORCEMENT. BY A. J. DIXON

THE old-style method of reinforcing manholes in the heads or shell of a boiler was to rivet on plain compensation rings, generally on the outside of the plate, but often on the inside, as shown in Fig. 1. The present practice is to flange the edges of manholes in the heads as shown in Fig. 2, while similar openings in the shell are reinforced by means of flanged steel frames or saddles double-riveted to the shell plate as shown in Fig. 3. These saddles are stamped out of steel plate while the metal is white hot.

A style of reinforcing that was formerly largely used for manholes in boiler shells was to rivet on a cast-iron saddle outside the shell. The only thing to recommend this method is the fact that it removes some of the difficulty of getting in and out of a boiler shell of small diameter. But this advantage is overbalanced by the objectionable features of the cast-iron frame. The treacherous nature of cast iron disqualifies it as good boiler material. The cast-iron saddle offers poor resistance to the flexural stresses caused by the tendency to radial deformation of the shell plate in the vicinity of the manhole; also, the peculiar distribution of the metal in castings of this form may be the means of causing initial strains while the iron is cooling in the mold. Another objection is that for the same size of manhole, a larger area of plate must be punched out of the shell where the cast-iron saddle is used instead of the steel saddle. Boiler laws forbid the use of cast-iron for reinforcing manholes.

Rules governing the inspection and installation of boilers aboard steam vessels require that flat stiffening rings of the style shown in Fig. 1 shall contain the same volume of metal as the section of plate removed from the head to form the manhole. In the case of a manhole of the dimensions 11 by 15 in., for example, the compensation ring would have to be approximately 2⅝ in. wide to meet this requirement—assuming the ring to be of the same thickness as the head plate.

The problem of properly reinforcing an elliptical manhole in the shell of a boiler admits of no easy solution; it involves consideration of certain stresses, the exact nature and intensity of which can be known only by precise experimentation. For lack of sufficient experimental data of this kind, the calculations for determining the dimensions of reinforcing rings are more or less approximate.

The transverse tension in the shell is the stress mainly to be taken into account in these calculations. The customary practice is to make the cross-sectional area of the reinforcing ring on a line through the longitudinal axis of the hole—usually the minor axis of the

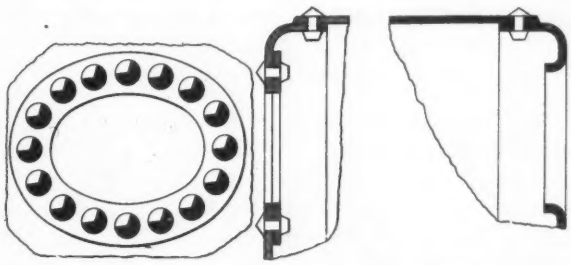


FIG. 1. FLAT COMPENSATION RINGS
FIG. 2. MANHOLE WITH FLANGED EDGES

ellipse, as along the line M N in Fig. 3—equal to the cross-section of the plate punched out of the shell, this section of metal being likewise calculated on the longitudinal axis of the hole. A ring so designed is regarded as amply compensating for the diminished strength of the shell against failure by transverse tension.

But besides the crosswise tension in the plate, consideration must also be given to the flexural stress caused by the tendency of the shell to become distorted radially. This distortion is due to the fact that the presence of the manhole destroys the true cylindrical form of the ring of metal in which it is located. The manhole cover

makes an irregularity in the curvature of the shell which the internal pressure tries to correct, and thus a bending stress is put upon an area of plate just fore and aft of the hole. To oppose this stress, it is necessary that the reinforcing ring be made deep. What the exact depth of the ring should be in any case is, however, in the absence of definite experimental knowledge, largely a matter of conjecture.

Assuming the dimensions of a manhole, as shown in Fig. 3, to be 12 by 16 in., the longitudinal axis, a b, of the ellipse cut out of the shell plate would be, say 15 in. Therefore, supposing the plate to be $\frac{5}{8}$ in. thick, the cross-section of this elliptical piece would be $15 \times 0.625 = 9.375$ sq. in.

But the plate section is still further reduced by the two rivet holes in line with the longitudinal axis of the manhole. Suppose these holes to be of $1\frac{1}{8}$-in. diameter. Then the total cross section of the material punched out of the shell along this line, and to be compensated for, is $9.375 + 1.125 \times 0.625 \times 2 = 10.78$ sq. in. Therefore the frame should have a cross section of $10.78 \div 2 = 5.39$ sq. in. on each side of the manhole.

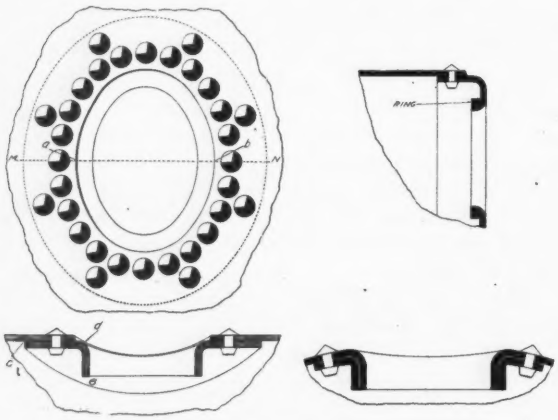


FIG. 3. REINFORCEMENT OF MANHOLE IN SHELL

FIG. 4. RINGED MANHOLE

FIG. 5. MANHOLE IN CONVEX HEAD

These frames are stamped out of steel plate about 25 per cent thicker than the shell plate, which would make the frame in this case $\frac{5}{8} \times 1.25 = 0.781{,}25$ or 25/32 in. thick. The width over all of the calculated section, that is, the distance from the joint with the manhead to the outer edge of the saddle, including the diameter of the rivet hole—the distance c d e in Fig. 3—should, therefore, be $5.39 \div 0.78 + 1.125 = 8.035$, or, practically, 8 in.

Manhole reinforcements of the kind here described are generally double-riveted to the shell. A correctly designed single row of rivets would make the job sufficiently strong against shear, but it would still be lacking in the necessary rigidity to oppose distortion by flexure. The widely spaced row of rivets running around next the outer edge of the frame, as shown in Fig. 3, secures this rigidity and thus insures a tight joint both for the manhead and the riveting.

Referring to Fig. 3, it is seen that the strength of the structure against failure by shearing of the rivets depends on the entire cross-sectional area of the rivets on either side of the longitudinal center line less the area of one-half of each of the rivets on the center line. The resistance opposed to shear should, of course, be made as nearly equal as possible to the tensile strength of the frame. Thus the construction acquires the maximum strength possible with the given materials.

Assuming a shearing strength of 42,000 lb. per square inch for the rivets and a tensile strength of 55,000 lb. per square inch for the saddle, the cross-sectional area of the rivets on either side of the dividing line should be $55{,}000 \div 42{,}000 = 1.3095$ times the net cross-sectional area of the frame. Assuming the driven size of the rivets to be $1\frac{1}{8}$ in., this would require

$$\frac{10.78 \times 1.3095}{1.125 \times 1.125 \times 0.7854} = 14.2$$

or, practically, 14 rivets. Therefore, including the two rivets on the longitudinal line, there should be $14 \times 2 + 2 = 30$ rivets in the complete job.

Unless the plate is exceptionally thick, the flanged edge of a manhole in the head of a boiler will not afford surface enough to make a serviceable joint with the manhead. To remedy this, the practice is generally followed of shrinking on a band, as shown in Fig. 4; the band being forged of steel or bar iron thick enough to make the bearing surface about an inch wide. Where the heads are convex, as in the steam drums of water tube boilers, the bands are often flanged to form reinforcing rings, as shown in Fig. 5.

Removing India Ink Marks

READERS of Power Plant Engineering will be glad to learn that India ink can be completely cleaned from tracing cloth. It is claimed that the liquid leaves no trace of the ink and does not injure the paper.

This article is manufactured and sold by E. H. Anderson, at 272 E. 199th St., New York City, and is guaranteed to do the work. It is sold under the trade name "Rasindia." W. L. FETHERSTON.

STAVANGER, NORWAY, has just decided to take a 10-yr. lease of a 12,000-hp. hydroelectric plant owned by a private corporation at a rental of $12.06 a year a horsepower. Delivery of power is to start on Jan. 1, 1918. The lease is made because of threatened shortage of fuel the coming winter, although the price is considered high. Power will be transmitted from Florli by a 3-phase current at 30,000 volts over steep mountain sides on a wood-pole line, which has at one point a span a mile long over a fjord, thus saving a distance of 18 miles in transmission line.

ACCORDING TO a late issue of Commerce Reports, a man in Italy desires to buy pipe fittings of all kinds, valves, etc., and wrought-iron flanges. Fittings must be of malleable iron. American manufacturers must be willing to manufacture fittings to conform with the demands of the Italian market. Quotations must be made f.o.b. New York and for the present, payment will be made by letters of credit on New York. Refer to number 25,168.

Superheater Operation

TROUBLES LIABLE TO OCCUR DUE TO THE FORMATION OF SCALE; FACTORS OF DESIGN TO PREVENT THESE

IN superheaters, steam is heated above the temperature of formation. It is necessary, therefore, to take precautions so that under ordinary conditions of working, the tubes or other iron parts in contact with the steam will remain at all times at a temperature well below that at which decomposition of the steam will begin.

Efficiency as well as safety demands that the steam shall be led past the iron surfaces in such a way as effectively to take up the heat transmitted from the furnace, and while different designers have arrived at different solutions of the problem, all successful superheaters are arranged so that the steam will pass through in sufficient amounts to absorb the heat from the iron so rapidly as to prevent a dangerous rise in temperature when working normally.

If, however, through abnormal or unusual conditions the steam flow is diminished in the whole or a part of a superheater, at a time when sufficient heat is being supplied from the furnace to heat the iron to redness, deterioration will take place, the extent to which it will proceed being determined by the length of time during which the condition prevails.

Superheaters may be broadly divided into 2 groups, those which are installed as an integral part of the boiler unit, placed directly in the path of the gases through the boiler setting, and therefore operated always in conjunction with the particular boiler to which they are attached; and those which are so set as to be heated by a separate and independent furnace in a setting distinct from that of the boiler or boilers. Such superheaters may serve more than one boiler, and are capable of independent control and operation.

In the case of superheaters of the first, or attached, type, the chances are against this sort of deterioration. In the first place, the superheaters are so proportioned relative to the boilers to which they are attached that the temperature of the steam will be raised a certain definite amount, and as the rate of firing is governed by the steam output, periods of intense heat will correspond to periods of great steam flow, and therefore there will be little opportunity for the iron to assume a dangerously high temperature. Two things should, however, be guarded against; one is the choking or plugging of one or more superheater tubes with scale or sediment, and the other is the possibility of the steam being shut off from the superheater intentionally. The first of these dangers will ordinarily be confined to boilers which prime. Priming is associated with a high content of solid matter in the feed water which is not precipitated by heat or solvents in the boiler proper, or in feed heaters, water softeners or purifiers. Indeed, solvents may in certain cases aggravate the trouble, especially if liberally used. (This is not to be construed as an argument against the use of chemical treatment for boiler water. The cases referred to are found in connection with troublesome waters and require the control of a careful chemist.) In this connection, it is perhaps well to point out a difference between the formation of scale in boilers and in superheaters. Many different sorts of solid matter may be dissolved in water, but it is convenient to divide all the dissolved matter into two classes. One of these represents all the material which is rendered insoluble at the temperatures found in a steam boiler and therefore is deposited as scale. The other consists of all the solid matter which stays in solution at boiler temperatures, and does not make scale. Chemists call the first sort insoluble solids, or incrustants, and the second sort soluble solids or non-incrustants, always referring, however, to boiler conditions where some water is always present as *water*. If we draw a sample of water from the blowoff pipe of a steaming boiler, and filter out any sediment it carries, it will naturally have little or none of the scale-making solids. They will be left in the boiler. It will contain, however, the full amount of soluble or non-incrusting solids. If, now, we boil the sample from the blowoff till all of it has turned to steam, evaporate to dryness, as the chemists say, the non-scale-making, or soluble solids will be thrown down as a scale or precipitate.

Coming back to the case of a boiler and superheater, let us trace the scale-forming activity of a small portion, say a pint, of water in its passage from the feed line to the superheated steam main. Our pint of water enters the boiler and is heated by the surrounding water to boiler temperature. After a time at this temperature, the scale-making stuff which it had in it at the start will be floating about in the boiler in the form of small particles of sediment, which as they pass along the circulation attach themselves to the boiler structure as scale, or else are deposited in the boiler bottom or mud drum as a sludge. The water, freed from its scale-making matter, evaporates, leaving its non-scale-making material behind it is a legacy to the water remaining in the boiler. Hence the amount of dissolved solid matter in a boiler constantly increases in concentration, in proportion to the rate of steaming. The only way to get rid of the soluble solids is to blow off a portion of the boiler water and replace it with fresh feed. We have assumed that our pint of water evaporated quietly into dry steam. It is well known, however, that if the soluble matter in a boiler gets too concentrated either because the feed is heavily charged to start with or because the blowoff has not been used sufficiently, the evaporation becomes less and less quiet, and the boiler is said to be "foaming." If the boiler foams badly, the steam picks up and carries along small particles of water in the form of spray, and the boiler is then said to be "priming." Now, when wet steam from a priming boiler passes through a superheater, the water entrained in the wet steam evaporates in the superheater and deposits its solids in the form of an incrustation. Hence a priming boiler will scale up a superheater, but the scale deposited by a particular water in the boiler would be different from that deposited from the same water in the superheater, since the boiler would get the insoluble or incrusting solids while the superheater would get the soluble or non-incrusting solids.

In designing superheaters for high efficiency, one solution of the problem of getting the greatest amount

of heat into the steam per square foot of superheater surface consists in passing the steam over the surfaces in thin layers. This means restricted passages, and hence a priming boiler might deposit scale enough in time to choke off a part of a superheater. As soon as this happens, the steam flow through that element is diminished, and may fall so low that it can no longer keep the iron below red heat if the furnace is hot enough. Then the steam is certain to be decomposed, with the result that the iron will be oxidized and rendered worthless for use as a container for steam under pressure. It is necessary, therefore, when superheaters are attached to a boiler, so to control the character and concentration of the feed water as practically to eliminate priming if all danger of choking the superheater passages is to be avoided. This can be done in most cases by the frequent and judicious use of the blowoff, though some waters may require special treatment. It is significant in this connection to note that the newest large plants, built to use high-pressure steam, highly superheated, have made provision that nothing but condensate or carefully distilled make-up feed shall be used in the boilers.

The other hazard to a direct connected superheater, mentioned above, would occur in cases where only a part of the total steam produced is superheated. If under such conditions it should happen that frequent calls for maximum boiler output should coincide with minimum drafts of superheated steam (that is, periods of minimum flow in the superheater would correspond with maximum furnace temperatures), then we should expect to find the superheater exhibiting decomposition.

With separately fired superheaters, it would seem that in the absence of any automatic thermostatic devices operated by the steam temperature which could be depended upon absolutely to control the fire, the only safeguard is to be found in eternal and intelligent vigilance, coupled with careful design and installation. The design should be such that at all rates of steam flow possible, there should be an ample flow of steam over all the superheater surface, and no elements should be robbed of their share by eddies or through a too rapid flow through the headers, as it has been found that if the velocity through the headers is too great, some of the tubes will fail to take their share of the steam current. The furnace and combustion chamber, with their attendant checker work and baffles, should be so designed that the flow of heat to the superheater elements will be uniform, with no excessively hot spots or corners to develop local troubles. For the rest, a careful and constant watch must be kept of the steam temperature, and the fires must be controlled accordingly. At every opportunity the elements should be inspected internally where possible, to see if there is any surface indication of the formation of a black oxide coating. If it should be found, it will be well to see if the conditions which led to its formation cannot be overcome, and if not it must be carefully watched so that every affected tube may be renewed before the disintegration has progressed so far as to menace the safety of the structure. With all separately fired superheaters, care should be taken when heating up from cold, to see that steam is flowing before the tubes have had any chance to acquire a dangerous temperature. In the same way, it is necessary when shutting down the superheater, to be certain that the steam flow is maintained for a sufficient time after the fire has been checked, to prevent any dangerous temperature rise.—The Locomotive.

Increasing Furnace Efficiency

FORCED CHANGE IN COAL LEADS TO MODIFICATION IN FURNACE DESIGN. BY C. B. HUDSON

IN these days of high prices, all grades of coal have increased and some grades have more than doubled in price, but unfortunately the heat value remains the same.

To illustrate, at our plant we have been using a mixture of bituminous slack and anthracite screenings. Our contract for the latter expired on April 1, at which time we were told that the price for the coming year would be an advance of over 200 per cent from that of last year.

Our management did not see fit to sign a contract at once, preferring to use from stock for a time to await developments, and when inquiry was made a short time later, we were told that new business had been taken on and they could not supply us. This alone would not be

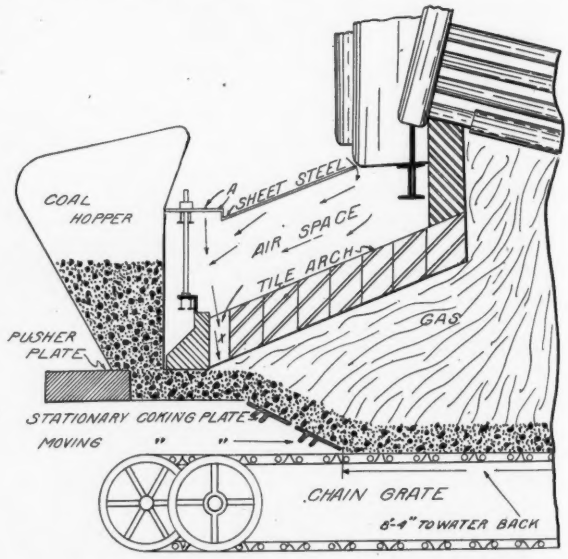


FIG. 1. METHOD OF ADMITTING AIR OVER FUEL BED

so bad if the price of bituminous were to remain the same, but this too is expected nearly to double in price.

I assume that our case is not isolated, but that the same condition must exist elsewhere.

How, then, are we to meet this increased cost?

In the industrial plants, no doubt, an advance in the price of the finished product will take care of this matter, the consumer ultimately paying the bill; but to those of us in charge of railway and lighting plants, where an increase in the price of electrical energy requires the sanction of the Public Service Commission, the question assumes a different aspect.

Of course, an increase in the over-all efficiency of the power plant sufficient to compensate for the increased price of fuel is out of the question; but the writer believes it is possible for all power plants, both industrial and central station, to increase their boiler and furnace efficiency by one or two per cent at least, which in the

aggregate would make a tremendous difference in the total amount of coal consumed during the coming year.

The writer knows of no way in which furnace efficiency can be increased as much for the expense as by the purchase of an Orsat apparatus for analyzing the flue gas, and a compound differential draft gage for each boiler.

This combination and a few hours a week spent in instructing the firemen in the principles of combustion and how to use the Orsat will produce paying results.

With a desire to learn what others are doing or have done to increase the boiler and furnace efficiency of their plants, the writer will give some of the methods used in our plant, which consists of two Edge Moor water-tube boilers fired by Green chain grate stokers. The installation is about two years old.

The fuel, as before stated, has for the past year and a half consisted of bituminous slack from the Knoxdale mine of the Pittsburgh and Shawmut Coal Co., and anthracite screenings from the Northern Anthracite Co., at Bernice, Pa.

These coals were mixed equal volumes which equaled about 1.2 lb. of screenings to 1 lb. of slack. This mixture burns very well if properly coked. The slack, being high in volatile, cokes easily and the particles of anthracite adhere to this coke, preventing a thick dead fuel bed which would be the case if the mixture did not coke well.

In order to produce a high CO_2 all air leaks around the front of the furnace were stopped up, the idea being to force all the air through the grate. This method produced excellent results, as we could maintain a high CO_2 yet produce no objectionable smoke.

Having consumed all our hard coal supply and started burning all bituminous, we find we have difficulty in getting a good CO_2 without making an objectionable smoke.

The writer's theory is that some air should now be admitted over the fire, and the accompanying sketch shows how we have accomplished this.

We drilled 6 1½-in. holes at the point marked X, where the gate tile and the arch tile come together, air being admitted as shown by removing sheet steel cover plate, A; this admits the air at just the point it is needed to mix properly with the gas and pass along under the incandescent arch.

One boiler was used for the experiment, and as it was done to reduce the smoke, the results obtained were highly gratifying, as it cut out objectionable smoke by about 75 per cent. Tests were made for CO_2, the sampling pipe being inserted just over the tubes in the first pass thereby avoiding any detrimental effects of air infiltration in second and third passes, these tests showed CO_2 as high as 17.5 per cent with but little black smoke. Our No. 1 boiler was now given the same treatment, except that the number of holes was increased to 13 with still better results, as we are now able to get from 17 to 18 per cent CO_2 with practically a clear stack, which proves that admission of air at the point shown has accomplished the desired results.

These figures for CO_2 may seem improbable, if not impossible, but we get them repeatedly, I would not have readers of Power Plant Engineering get the impression that these figures are common practice, but we can get them by careful attention to the condition of the fuel bed, however readings of 15 to 17 per cent CO_2 are common in our practice. We have an Orsat apparatus which we keep connected in a convenient position all the time and our firemen have learned to use it and take pride in seeing how high they can carry the CO_2 without getting a smoky stack.

The writer regrets that no figures as to boiler efficiency since making these changes can be given, results for June being lower than usual, due to labor troubles which necessitated breaking in nearly a whole new fireroom force.

The writer would appreciate reports of boiler and furnace efficiency for monthly periods in the columns of Power Plant Engineering, as some of us may have an idea we are getting a pretty good average efficiency, which ideas may change if we find out what the other fellow is getting.

Our boilers are equipped with compound differential draft gages and we find them very useful.

These gages and the damper control, which is hand regulated, are located as shown in the sketch.

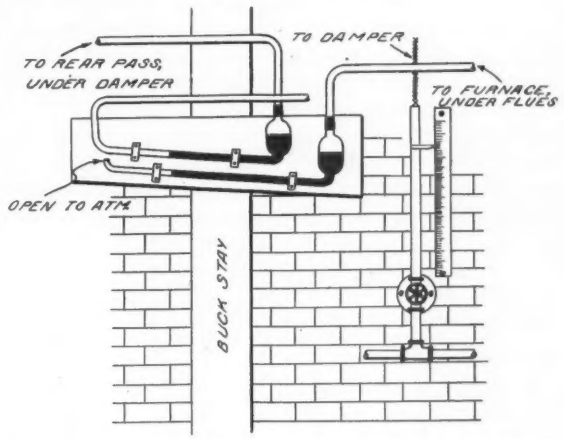


FIG. 2. SKETCH OF DRAFT GAGE CONNECTIONS AND DAMPER POSITION INDICATOR

The draft gage is connected as shown, the lower scale showing the drop through the fire and the upper scale showing the drop through the flues; the sum of the two is the total draft at the damper. The damper control is made of a 1¼-in. pipe flange bolted to the brick setting by expansion bolts into which is screwed a short nipple, a 1¼-in. tee is screwed onto the end of the nipple, the ends of the tee are bushed down to 1 in., the threads in the bushings being filed out so that a ¾-in. pipe slides through easily. The damper chain is made fast to a short piece of ¾-in. pipe which for convenience is fitted with a tee and two short pieces of pipe. A hole is drilled in the side of the 1¼-in. tee which is tapped out to receive a ½-in. screw; an old valve hand wheel makes a convenient means of loosening and tightening this screw, which is for the purpose of holding the ¾-in. pipe when the damper is open to the required point.

A pointer on the ¾-in. pipe and a scale marked in ¼-in. divisions complete the arrangement.

By locating the damper control and the draft gage together, the fireman can adjust the damper to give any desired draft.

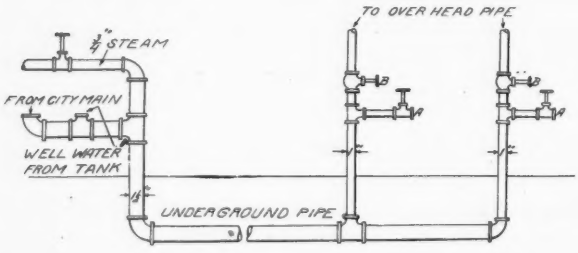
From data taken from our daily log sheet for 18 days in May, during which time only bituminous coal was burned, our boiler and furnace efficiency showed 68.4 per cent.

With the changes described in this article, it is hoped that we can do better than this during June.

Draining Steam and Water Pipes

FROZEN PIPE AND METHOD OF PREVENTION. BY H. A. JAHNKE

A FEW YEARS ago, the writer found that it pays, and pays well, to inspect the heating system under your charge before cold weather sets in. At that time, about 700 ft. of 2½-in. pipe which ran from the boiler room through the factory yard into the office, supplying exhaust or live steam for heating, were frozen solid, all due to the fact that the 2½-in. pipe had settled at once place, the hangers being broken or loose, and had formed a pocket where water had collected and frozen during the night. Exhaust steam was turned into the pipe the next morning, but as it could not get through, the steam condensed quickly, causing the pipe to freeze solid from where the pipe sagged up to where it enters the boiler room. I did not notice this until notified by the office force that there was no heat in the office, when I found that the feed pipes were frozen. It was necessary to disconnect every length of the 2½-in. pipe which was located outdoors,



CONNECTIONS FOR DRAINING UNDERGROUND WATER PIPING

in order to thaw them out, which was done by means of a steam hose which was entered at one end of each length of pipe. To disconnect, clear them of ice and connect the pipes again, most of the day was taken, making it necessary to lay off the office force for that day, all on account of not inspecting the heating system before very cold weather set in.

VALVES LEAKED BADLY

IN ANOTHER INSTANCE, about 400 ft. of 3-in. pipe which feeds the steam coils and radiators in the factory with live steam or exhaust steam, was frozen up solid one Monday morning. The building is not heated nights or Sundays. On this morning, steam was turned on as usual, but it was noticed that the steam did not get through. In looking for the trouble, it was found that the 3-in. feed was frozen solid for about 400 ft. from the engine room on into the factory, due to the fact that a valve on top of the boiler was not closed tightly on Saturday night, or it leaked, which allowed a little steam to leak into the 3-in. pipe in the factory, where it condensed, filling the pipe with water. During this time, it took about 4 hr. to thaw out the pipes by applying heat to the outside with blow torches. That this might not happen again, another valve was placed on the line, and a drain pipe between the two valves which will take care of the leakage of steam by the first valve. Should this leak, or not be closed tightly by mistake, the second valve is placed in the line to make sure that no steam or water gets into the 3-in. pipe outside of the engine room at night—both valves are closed and drain valve opened during cold weather.

DRAINING WATER PIPES UNDER GROUND

IN OUR PLANT some of the water pipes are located under ground where they run through the yard. During cold weather it becomes necessary to drain these as well as the overhead pipes when no water is used, as the building is not heated during the night or Sundays. Either city or well water from a tank can be run through the pipes, then distributed to the different departments by branch pipes overhead. To drain the overhead pipe, the water is shut off on the underground pipe from the city main or tank, whichever water is used, the drain valves A, A, are opened to drain the overhead pipes then valves B, B, are closed and steam is turned into the underground pipe and left on until steam appears at the two drain valves, A, A, when all the water is blown out of the underground pipe. The two water and steam valves must always be tight, otherwise the underground pipes are liable to be filled with water again.

Weight of a Column Foundation

THE WEIGHT or mass of a concrete foundation for supporting a structural steel column should be such that the column cannot be overturned—or drawn away from the earth—by the stresses that are normally imposed on it. Experience shows that the following is a safe rule. Ordinarily, a column which is strained in tension at its base should be anchored to its foundation by bolts sufficiently long to engage a mass of masonry (concrete) such that the weight of the foundation, in pounds, will be at least 1½ times the tensile stress on the anchor bolts, in pounds. TERRELL CROFT.

THE CONSTANT MOTION of a wire rope involves heavy strains and internal friction, and requires that the wear should be equally distributed. Lubrication will greatly prolong the working life of a wire rope. The initial lubrication used to lay up the hemp core around which the strands of the rope are wound is an important factor, as it should not only retard the effects of friction, but also act as a preservative by minimizing internal corrosion. When a rope is properly lubricated from the inside less external lubrication is necessary, and the same lubricant should preferably be used in both cases to obtain uniform results. The necessity for careful lubrication will be realized when it is stated that the wearing or bearing surface of 100 ft. of 1-in. diameter wire ripe is about 334 sq. ft., whereas the bearing surface in a 35,000-hp. reversing engine, one of the largest in the world, is 319 sq. ft.—Mechanical World.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Testing Lamps and Fuses

METHODS AND APPARATUS EMPLOYED TO FACILITATE LOCATING TROUBLE. BY J. C. HAWKINS

MANY engineers of isolated plants supplying current for a large number of lamps or small motors frequently experience much trouble in connection with the fuses used to protect the distribution circuits.

In the writer's plant there are 288 3-pole main distribution 30- and 50-amp. fused switches each of which feeds one or more panel boxes containing from 10 to 20 2-pole fused branch circuit switches from which the individual lamp outlets are supplied. In addition to this, there is a considerable number of 2-pole fused switches on motor circuits, the system being a 112-225-v., 3-wire, direct-current system. All fuses are of the standard cartridge type. Each switch is marked with a letter and number, to designate the panel box which it feeds; but in case a lamp or group of lamps does not burn, it

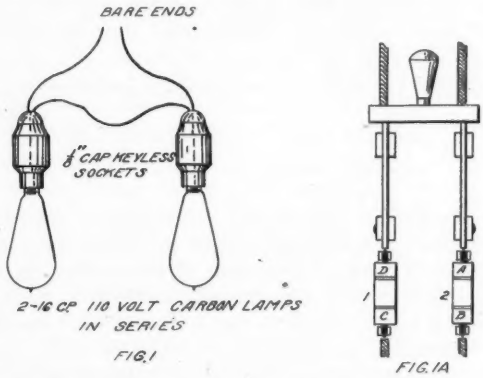
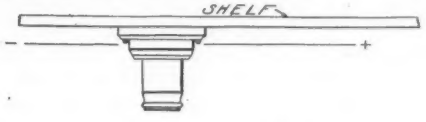
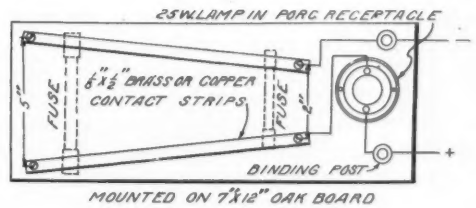


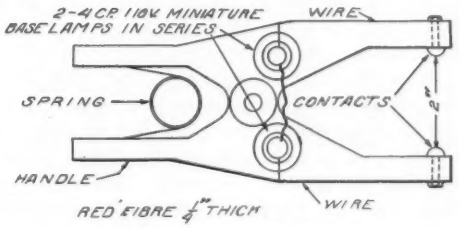
FIG. 1. TWO 110-V. LAMPS CONNECTED IN SERIES ARE WELL ADAPTED FOR WORK ON 220-V. CIRCUITS
FIG. 1-A. TYPICAL CUT-OUT SWITCH AND FUSES

sometimes requires considerable time to locate the defective fuse.

One of the simplest means of discovering such a defective fuse is by means of the test lamp shown in Fig. 1. In this outfit 2 110-v. carbon lamps in keyless sockets are wired in series. The bare ends of the leads are touched to the switch blades, and if the lamps light, the fuses are not blown. If the lamps indicate no current, each fuse may be tested separately by touching one terminal below and the other above the fuse, as shown in Fig. 1A. If points A and C are touched and the lamp lights, fuse 1 is sound. If the terminals touch points B and D and the lamps do not light, fuse 2 is defective. This is assuming that the current enters at the top or jaws of the switch as it should. Two lamps are used in series for the reason that the outside voltage of the 2-wire circuit is 225 v., and only 110-v. lamps were available. When used across the 110-v. circuit, the lamps will burn at about one-half normal candle power; but any light indicates that the circuit is closed. This tester







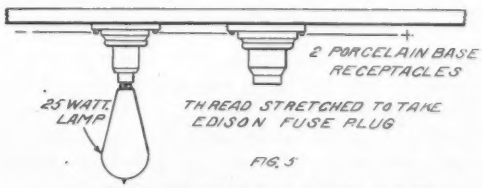


FIG. 2. A READILY MADE LAMP TESTER
FIG. 3. A TEST BOARD OF THIS DESIGN WILL READILY ACCOMMODATE VARIOUS SIZED FUSES
FIG. 4. THE TESTING FORCEP HAS MANY ADVANTAGES OVER THE SCHEME INDICATED IN FIG. 1
FIG. 5. A CONVENIENT TESTER FOR EDISON PLUG CUT-OUT FUSES

requires both hands to operate it, and is somewhat cumbersome to use.

Where there is a large number of switches to test, or one is in a hurry, the testing forceps shown in Fig. 4 are very convenient. These forceps, so called, are

made of ¼-in. red fiber, and have two miniature-base 110-v. lamps mounted in miniature sockets. The lamps are connected in series (for 220 v.) and are connected to the contact screws at the end of the blades. If used on 110-v. circuits only, one lamp is sufficient. The contact screws are held against the switch blades or fuse terminals by the spring between the handles, and the tester can be operated with one hand. For locating defective fuses, this instrument has some advantages over the arrangement shown in Fig. 1.

Blown cartridge fuses of the standard approved type are not as a rule refillable, but may be made so by removing the caps and filling powder and inserting a piece of fuse wire of the proper size. The ends are then soldered to the caps. In some plants this is done when a large number of them have accumulated. It is desirable at such times to have some means of quickly testing them, and sometimes it is desirable to test those found lying about the bench to see whether they have been blown or not. This can be quickly done on the test board shown in Fig. 3. This consists of a dressed hardwood board on which there is mounted a porcelain base keyless lamp socket connected to one or two copper or brass bars, the other being connected directly to the line. The bars are set at an angle to accommodate any length of fuse which may be tested as shown dotted. The lamp indicates whether the fuse is blown or not. The parts are mounted and the board fastened to the wall above the bench where it is always ready for use.

Where the lighting requirements are exacting, as in public buildings, museums, art halls, etc., it is necessary to use a large number of small lamps to get the proper lighting effect, and if one or two lamps of a set should burn out it is necessary to renew the entire set as the renewal of one lamp would cause a noticeable unevenness in the light distribution. These partly used lamps may be used to replace those burned out in less conspicuous places or where the lighting requirements are less exacting. It is desirable, however, to test them before being taken out of the shop, as some will be found with the filament broken, especially if they are of some high efficiency type. It is also desirable in some cases to test new lamps, which can be quickly done by means of the tester shown in Fig. 2. This tester consists of a porcelain base keyless socket fastened to the underside of a shelf, or to the wall with the test circuit connected to it. Instead of screwing the lamp into the socket, the threaded base is expanded by hammering it out on a round shaft, so that the lamp will slip in and make contact. With this socket the lamps can be quickly tested. Sometimes good lamps accidentally get mixed with those burned out, and it is advisable to test those supposed to be burned out before being thrown away.

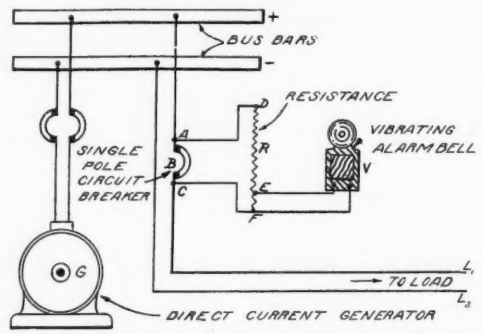
Edison plug cut-out fuses have a mica top and usually indicate when they are blown. Figure 5 shows an arrangement whereby they may be quickly tested before being thrown away or after being refilled. This tester consists of a lamp and fuse socket in series. The fuse may be screwed into the socket, or it may be expanded so that the plug may be easily inserted as in Fig. 2.

Where there is a large number of lamps and fuses to be tested, the installation of a convenient method of testing them will save much time in keeping the lights burning, and there is practically no first cost of material, as all of the devices shown can be constructed from discarded apparatus, and partly burned out lamps can be used if desired. The convenience of this device can only be appreciated after using it for a short time.

A Simple Power Alarm

By Terrell Croft

In a certain plant in which electrical power was transmitted for a considerable distance, some difficulty was encountered due to the delay which sometimes occurred in closing circuit breaker, B, Fig. 1, at the power station after an overload had occurred at the far end of the line. The delay was due to the fact that the duties of the station engineer were such that he could not remain permanently in the power house to watch the circuit breakers. An alarm to notify the engineer of the opening of the breaker was improvised as shown. The circuit breaker, B, protecting the line, was of the single-pole type. A high resistance, DF, was connected around the circuit breaker at the points, AC. Then an ordinary vibrating bell was connected across a portion of this resistor, as shown at EF. When the circuit breaker is closed, practically no current goes through



CIRCUIT DIAGRAM FOR ALARM BELL

DF or through the electric bell, V, because the path, AC, through the circuit breaker offers much less resistance. If the circuit breaker does open, however, then current will flow through DF and through the bell, V, provided the line, L_1L_2, is closed at the load end by a machine being connected across it, or due to some other cause. With the circuit breaker, B, open, if the vibrating bell then rings continuously, it indicates a short circuit at the end of the line. The bell will continue to ring until the circuit breaker is closed. This audible signal never fails to attract the attention of the operator, who then closes the circuit breaker.

In New Zealand three sources of power are recommended for improvement by the Public Works Department. One is in the Hawks Bay district for future development; another at Arapuni Gorge for the Auckland district, for 30,000 hp., at a cost of $5,460,000, and a third of 25,000 hp. on the Mangahao River for the Wellington district at a cost of $4,800,000.

Brass or bronze when stressed above the initial elastic limit, and the full stress is maintained for a considerable length of time, will fail by cracking as soon as oxidation takes place on the surface.—Mechanical World.

Treatment for Fibrous Transmission Rope

EFFECTS OF GRIT, MOISTURE AND VARIOUS OILS ON THE LIFE AND CONDITION OF ROPES

FOR several years, I have been in charge of a rope drive in the forging department of our factory, the power coming from a gas engine and being distributed to line shafts by the American system. The air is dry, hot and charged with steel scale from the work and dust from the concrete floor.

There is much trouble from ropes breaking, and by the end of 3 yr., at most, a rope becomes so rotten that making a splice is impossible. Also, the ropes, instead of wearing out internally, are worn by contact with the sheaves, although somebody's great grand-dad once averred that ropes always give out by grinding internally, and his say-so has been passed on to this day.

We would expect rope to give better service when located where the air is reasonably moist, and we find that, in winter, when steam is blowing freely from the pet cocks of the heating coils, there is less trouble than in summer. We use exhaust steam for heating, so do not have to be saving of it.

We find that when we can catch a broken strand in time, we can lay in a new strand in its place in one-fourth the time that it takes to make a splice, and in many cases it lasts as long as a new splice. Also, where the rope is rotten and many of the fibers worn in two, we can wrap fine twine around the strands and thus make a splice where otherwise the strands will fall in pieces while handling. After the stretch is about out, we take up only enough for the splice, regardless of whether the tension carriage is up or not; otherwise we are liable to have to splice in a piece in case of future breaks.

We tried the English drive with individual ropes on some of the small runs, as this, if successful, would have avoided shutting down while splicing a break. The remaining ropes could have carried the load while the broken one was being spliced ready to replace. But the irregular speed of the gas engine, when it missed an explosion, and the variable load caused the ropes to jump off the sheaves as soon as there was a little slack, and the ropes tangled in the clutches of the sheaves.

We have used some dressings but, as they seemed to catch the grit and scale with which the air is charged, we think them harmful rather than helpful. The gummy surface and grit seem to add to the grinding effect of the sheaves on the outer strands of the ropes. We are looking for some dressing which will penetrate to the core without soaking the rope in a tank and without forming a sticky coating on the outside.

I have thought of using steam jets in warm weather to moisten the air; also, of spraying water on the rope, but neither looks very good to me. I believe, however, that if we could find some way to keep the necessary moisture in the rope it will do away with a great part of the trouble.

One new rope was thoroughly doped with lard oil and linseed oil, as we thought it might help and there seemed to be no chance to lose by the experiment, for that particular drive was far from working satisfactorily anyway. It has not come apart yet, so I think it did no harm, but cannot say that it did any good.

The ropes are very satisfactory, because the slip is small, but we would like some experiences of others on their rope drive troubles to see if they have solved any of the problems that we are having. J. O. B.

In an endeavor to get some information which might be of help to the above correspondent, letters have been received which we believe will be of interest to readers in charge of rope drives, parts of which follow:

FOR ANY DRIVE where dust or grit of any kind is flying through the air, we certainly would not recommend dressing the rope with any external preparation, for it simply affords a fine resting place for the grit. We have in mind now a case where one of our customers had a similar trouble with a drive in a cement mill. They had continually doped the rope with some kind of dressing and the dust from the mill had set into the grooves, forming practically a solid piece of cement over which the rope was grating day after day. We supplied a rope which was internally lubricated and they have had no trouble since.

In winter there is less rope trouble, naturally, due to the fact that the air is kept damp by the steam which is escaping into the room, and tends to keep down the dust. But it is poor practice to try to extend the life of a transmission rope after the fibre has started to disintegrate. Under the circumstances outlined, we should say that a rope that lasts 3 yr. is doing just as much work as can be expected from it.

"It would be bad to put any water on the rope, as it would simply swell up, then begin to shrink and then there would be all sorts of trouble that your subscriber had never thought of. Our recommendation would be to buy a rope having the center yarns of each strand laid in graphite lubricant and also the entire core; all the other yarns to be dry and not lubricated at all. In this way any dust or grit which alights on the drive will have no particular cause for sticking to the rope, and we believe the drive will give far better service than before." COLUMBIAN ROPE CO.

"WE ARE GLAD to try to help any man who is giving time any thought to transmission problems, for most belts and ropes are cared for by the blessed supervision of Providence and little else.

"Wearing of the ropes from street and concrete dust on the outside is different from the experience in many plants and is probably due to the sharp particles in unusual number. Generally ropes do grind out from the inside first from the friction between the dry fibers and in some large drives in dry places, the floor will be powdered thick under the drives with the dust from the rope fibers. Cases have come to our notice where the core has been entirely ground away. To avoid this, some ropes are made without a core, while others have a lubricated core to lessen internal friction.

"We believe that, while the moisture from steam has helped keep the ropes from getting dry, it is also one cause of their rotting out faster than you think they should. If a new piece of clothesline is left out through the winter, you can almost break it with your hands in the spring. Ropes in the standing rigging of vessels

are tarred to keep out water, for nothing rots rope as fast as to remain damp.

"Rope like wood fiber becomes brittle when dry, but like wood loses vitality and rots when remaining damp and exposed to the oxygen of the air. Thus the moisture method of keeping rope soft is harmful and defeats the ultimate purpose of securing long life, for the sake of a temporary benefit.

"What is really needed is something which will penetrate the rope, keeping the inside fibres pliable, while maintaining their vitality, reducing the friction on sheaves so far as possible, and cutting down the element of slip to the minimum possible. Lard oil and linseed oil will not do it. The former is not so bad, but is not particularly preservative of rope fiber and may contain fatty acids which are bad. The linseed oil is distinctly bad, as it is the most gummy oil of commerce, hence its use in paint. This gum in the oil oxidizes and becomes more brittle the more it dries out and oxidizes. Therefore all fibers coated with it will crack more readily as soon as the oil coating becomes brittle enough to crack. Also, the gum will tend to collect more dust, hence will increase the grinding action.

"Preservative which we make is composed of neutral oils and greases which will penetrate a rope by repeated applications, hot and a little at a time. It will keep the fibers pliable, waterproof and in good condition, so that they do not dry out, break or grind on their neighbors. The rope becomes brown to the core, and after standing a long time will show oily and in the best of condition clear through, as is proved by numerous specimens in our possession and in use in numerous plants."

CLING-SURFACE CO.

Refrigeration by Vacuum

A System for Brine Only Without Ammonia or Other Gas

REFRIGERATION without the use of a gas of any kind is almost an anomaly, but the newly developed Westinghouse-Leblanc machine is of this class and is successful.

For the refrigerating element, a simple brine solution is used, evaporation of a part of this element under vacuum producing a cooling effect which self-cools the brine.

It is well known that water at ordinary temperature will, if placed in a high vacuum, be partially evaporated, the absorption of heat to produce this evaporation being so rapid that a part of the water may be frozen. The same action is possible with brine, only that the cooling will not be sufficient to freeze the brine.

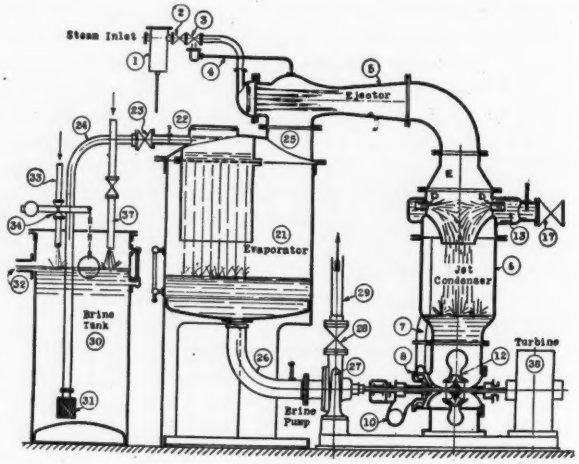
In Fig. 1, 30 is a brine tank from which the brine is drawn by vacuum maintained in evaporator, 21 and condenser, 6 by the air pump, 8 and valve, 23 regulates admission of brine to the evaporator so that it falls through a sieve in a fine spray, part of it evaporating under the high vacuum, thus cooling the rest which falls to the bottom and is drawn off to the brine coils by pump 27. From the coils, the brine returns to tank 30.

To remove the vapor formed in the upper part of the evaporator, a steam jet is used in ejector 5, carrying the vapor to condenser 6 where both vapor and steam are condensed; either jet condenser, as shown, or the surface type may be used.

Condensate is drawn off by pump 12 and may be used for any purpose for which it is suitable, or thrown away.

For its efficiency, the process depends upon high vacuum, which is made possible by the Westinghouse-Leblanc air pump of which section is shown in Fig. 2.

This has an inlet for water and another for air, the water carrying the air away between slugs with a piston effect as in the mercury pump for high vacuum.



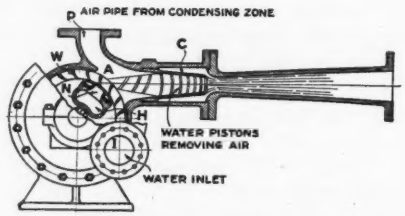


FIG. 1. DIAGRAM OF ARRANGEMENT OF WESTINGHOUSE-LEBLANC REFRIGERATING MACHINE

FIG. 2. SECTION OF AIR PUMP FOR REFRIGERATION CONDENSER

Size and weight of these machines are said to be about half those of compressor machines of like capacities, the efficiency is good and absence of gas under pressure avoids all danger from leakage or explosion. Also the three elements, water, salt and steam, are easily obtained at any point where refrigeration is needed.

THE WORLD'S production of copper during 1916 amounted to 1,396,600 tons, as compared with 1,061,300 tons in 1915, 923,909 tons in 1914, and 1,066,000 tons in 1913. Of the 1916 production 880,880 tons are credited to the United States.—Chicago Commerce.

FROM PRESENT reports, the second issue of Liberty Loan bonds will be offered for subscription in a few weeks and it is good policy and good patriotism to prepare by making savings now for investment in these gilt-edged securities.

Thermostatic Control for House Furnace

FOR USE on a house furnace, particularly where hot water or steam is used for heating, G. E. Ocain, chief engineer for the Wieboldt department stores, has devised the scheme outlined below for regulating the room temperature automatically.

The wheels, A and A′, are attached to the ends of a short shaft around which is wrapped a cord supporting a weight. The wheel, A′, is really a crank disk, the pin of which works the chains controlling the positions of the damper in the ash door and the check damper. In one dead center position the draft is on with check closed, and in the other dead center position the fire is checked. The motive power is the weight which gives the shaft a half turn whenever the arm, B, in wheel A, is released by the dog, C or C′.

Solenoids E and E′ take current from the battery, K, the circuit being closed through the thermostatic element, H, when the room temperature reaches the desired maximum or minimum. Thus, when the temperature is high, the brass expands more than the steel

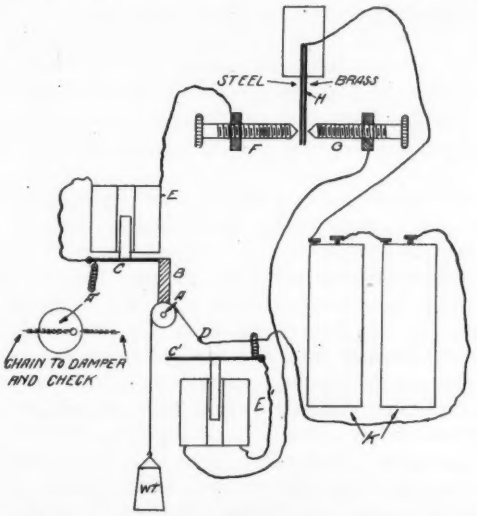


DIAGRAM OF AUTOMATIC TEMPERATURE CONTROLLING SYSTEM

and makes contact with the adjustable screw, F, causing current to flow through solenoid E, dog C, arm B, and brush B, back to the battery. This circuit is instantly broken when dog C is lifted by the magnetic attraction of solenoid E, releasing arm B, which is turned by the weight until it comes in contact with dog C′. The crank, A′, is thus turned to the opposite dead center, shutting off the draft and opening the check damper. The electric circuit is again closed when the temperature drops and causes H to swing into contact with G, then arm B returns to its original position. The contact points are readily adjusted to care for a temperature variation of 3 or 4 deg., and the only attention necessary is to see that the weight does not run to the end of the cord. Winding the cord is done by turning the arm, B, in the opposite direction.

Thermostatic element H is made up of strips of steel and brass riveted together at several points, one end being securely fastened in a fiber block. C and C′ are strips of iron to which solenoid plungers are attached. They are held in the out position by light springs. Wheel A has a metal rim which is in electrical contact with the metal arm, B.

While this device was designed for a house heating system, the principles are applicable to many conditions about power plants where automatic temperature control is desirable.

Cost of a Modern Underfeed Stoker Installation

By John D. Morgan

IN many of the various engineering papers, considerable discussion has of late been given to the installation cost of underfeed stokers. There seems to be a wide variation in the data given, and most writers fail to give the cost of the auxiliary apparatus necessary to the successful and economic operation of the modern underfeed stoker; for instance, no mention is made of the cost of the automatic control, stoker motors, instruments and gages, erection labor, damper regulators, forced draft fans, etc., all of which are quite essential. The costs given below were obtained from an installation of four 16-retort underfeed stokers with a total nominal rating of 5500 b.hp. and capable of 300 per cent rating for 2 hr. This installation was made in the latter part of 1915, consequently about 50 per cent should be added to bring the costs up to the present day costs. As will be noted, no foundation costs are given; this was not done, for foundation costs are generally assumed to be building costs.

Item	Cost per B.hp.	Per cent of Total Cost
Stokers	$4.84	62.6
Shafting, sprockets, chain drive	.455	5.89
Stoker motors	.241	3.12
Instruments and gages	.300	3.88
Front wall	.209	2.71
Erection labor	.224	2,89
Damper regulators	.030	.39
Bond	.029	.38
Forced draft fans with motor drive and starter	1.405	18.18
Total	$7.72	100

IN THE COURSE of the hearing before the Public Service Commission of New York on the case for raising the fare on upstate electric railways from 5 cents to 6 cents, it was brought out that in 1916, 14 of the 28 petitioning companies failed to earn their fixed charges. The cost of all kinds of electric apparatus by street car companies has risen 50 to 125 per cent since 1914. Labor costs have advanced 30 to 40 per cent, steel plates 700 per cent, copper 120 per cent, steel castings 100 per cent, forgings 340 per cent, brass 200 per cent and coal 80 per cent. Other materials have risen in cost from 27 to 200 per cent, so that the increase asked for would not make up for the increase in operating cost. Unless relief was granted, it was stated, companies could not keep up service, and some must go into receivership.

Some Firing

THE FIREMAN'S STORY ABOUT BRIEF DIRECTIONS AND SCATTERED WITS

OLD STONE, as everybody about the plant called him, is a silent, dependable fireman who has been in charge of the boiler room for years. His economy of language and a habit of going about with a half frown, half squint, watching to see that everything about the plant is running perfectly, have earned him the reputation of being a mild grouch, although nobody in the force has ever had a harsh word from him, and he has been the first to offer help when any trouble arose.

The plant is a small one, two 200-hp. return tubulars and the usual accompaniment of pumps and heater, but there is much piping for heating and steam kettles, and the coal has to be wheeled in, so there is always a helper to do the heavy hauling and tend boilers when Old Stone is fixing up a leaky kettle or coil.

About a month ago the helper got a job in a new plant that has been built near by to manufacture gas tractors, and the Chief hired a young man who had driven an automobile truck and fired a boiler for a threshing outfit to fill the void. Evidently he had been used to "engine trouble," for he had formed a habit when starting a new spell of activity of straddling to a well braced attitude, rubbing his hip with one hand and his chin with the other, gazing into space and exclaiming: "Now, le' me see; le' me see." Whatever his name, it was soon lost, and he became Le'mesee or, for short, Le'me to all hands.

Habit was strong, and maybe he liked the distinction. At any rate he continued to preface every new task and punctuate every interruption by his familiar pose. He would listen to the Chief's careful instructions about cleaning fires, then watch while Old Stone demonstrated the operation on one side of the grate. Then he would straddle out, consider the matter and sing his refrain for a little; grab slice bar and hoe and do a thoroughly workmanlike job. He was a good fellow, and learned quickly, so nobody paid much attention to his peculiar trick except when he got in the way or delayed a hurry-up job while he exhorted his guardian angel to "le' me see."

One day the fed pump got to jumping and knocking, due to a loose tappet and a tight rod packing, and Old Stone, as he gathered up an armful of wrenches, packing, and such, preparatory to a kettle fighting trip, said, with typical brevity, "That damn pump! Make 'er run."

Leme went over to the pump and le'me seed at it as usual, but as it was behaving fairly well, he ambled over to the coal pile, carted in a few barrows of fuel, and fixed up some thin spots in the fire that looked like possible holes. When the load on the engine jumped, the feed regulator opened up and the pump began to speed up with a series of jumps and knocks that called for immediate help.

Leme did his best, trying to get a position of tappets that would stop the knocking yet let the piston make full stroke; but the stiff packing held her up before she reversed unless the tappet was set over so that steam carried clear through, and then she hit the head. Leme hadn't struck a tight rod before, so he fussed away, reversing by hand and le'me seeing at intervals, forgetting all about the firing in his effort to keep up the water.

Shortly the Chief raced out from the engine room with more energy than grace and exploded, "What in blazes is the matter? Your pressure's down to 60, and the engine's almost stopped!"

"Now, le' me see. Le' me see," said Leme.

Well, the Chief took a grip on the spare part of Leme's overalls and the place where his spinal column started downward, walked him over to the boiler, pointed to the steam gage, opened the firing door and shoved the scoop at him.

"Look, see," said the Chief. "And keep on looking 'til you see 100 lb." Then he went over and tinkered with the pump until she was peacefully pushing the water level steadily but slowly upward.

Once a month each boiler came in for a general cleaning and inspection, the job being done of a Sunday, as we couldn't spare capacity or time during the week. So on a bright May morning, Old Stone and Leme met at the plant to give No. 1 her monthly treatment. Out-of-doors was particularly attractive, and both were anxious to get the job over so as to be away early.

Steam had been let down the night before on No. 1 and the fire banked on No. 2 as usual so that she carried about 25 lb., just enough to keep the kettles warm and prevent the mixture from sticking up the valves and piping. The routine was to clean No. 1, get up low pressure and cut her in with No. 2; then bank both boilers so that they would be ready Monday morning.

Old Stone took command and soon the water was blown down, manholes and hand holes opened and the sludge washed out. While Leme chipped scale from the heads and scraped the tubes, Stone rolled in a couple of loose ends, replaced some warped bars, cleaned out the combustion chamber and knocked clinkers off the side and bridge walls. Then looked over seams and rivets carefully with hammer and scraper to catch any leaks or cracks.

Leme emerged from the depths and Stone questioned, "Done?"

"Now, le' me see. Le' me see,—"

"I'll see. Clean those handhole plates. Pack the blowoff valve. Be out in 20 minutes," and Stone climbed into the boiler.

In 25 min. Stone reappeared and as Leme was finishing the valve, Stone went ahead closing up manhole and handholes. When Leme stopped, Stone looked over his shoulder and commented, "Feed pump rod, pack the water end. Grind the valve on heater line. And fire up."

Leme, after the usual soliloquy, went at the rod packing, started up the pump through the bypass, then went into the engine room, where the heater was located and got busy for a half hour on the valves. With that finished, he came back to the boiler and proceeded to

start a brisk fire under No. 1 as per schedule and orders.

When the gage showed 26 lb. he opened up the draft and started for the main stop valve to cut her in on the header. As he went up the ladder, he caught sight of the gage glass, and stopped short, yelling "Old Stone! Old Stone! Old Stone!"

From the wash room Stone came on the run, grunting, "What's matter?"

Halfway up the ladder, Leme was rubbing his stubble patch and called, "Le' me see. I can't see any water."

Stone took one look at the glass, tried the lower cock and got a jet of dry steam, grabbed the biggest scoop and dove for No. 2 ashpit. The fire in No. 1 was buried in a foot of ashes in record time; and then Old Stone used up a considerable part of the language he had been saving up for some years in telling Leme the various kinds of a fool he was for putting a fire under an empty boiler.

When he got through with the exercise in language, he asked, "Why in the name of seventeen idiots didn't you open that feed valve from the heater line when you got it ground?"

"Le' me see. I didn't grind that. I fixed the valves each side of the bypass and thought you'd open the feed valve when you had the boiler closed up."

"Well, that feed line valve was the only one that leaked, and I supposed you'd know enough to open it and fill the boiler when you got the valve done. Now we'll probably have to lay up No. 1 and put in a couple of new sheets and half a dozen tubes—," and the torrent of words again drenched poor Leme.

When the boiler and the argument had cooled sufficiently to permit of inspection and analysis, they decided that there was no particular harm done, and that the leaky valve had saved the day by letting enough water dribble in to prevent burning the plates, and that was what had gotten the pressure up to 26 lb. So they shook hands, proceeded to fill up, fire up and cut in.

But it was noticeable that afterward, Old Stone gave very full directions for all work which he delegated to anybody about the plant; and Leme, although he did not lose his nickname, gave strict attention when receiving directions, and looked at the water gage first, last and between times whenever he was anywhere about the boiler.

In a Show-Case Engine Room

FIRST COMBINED GAS-STEAM ENGINES TO BE PLACED IN PRACTICAL USE ARE SHOWN TO ADVANTAGE IN FORD CO. PLANT

IN THE summer months, an average of 400 visitors a day are conducted through the factory of the Ford Motor Co., at Detroit, and each inspection tour is now terminated by a visit to the engine room of the recently completed power house.

Facing lengthwise upon one of Detroit's prominent thoroughfares, the power house is 250 by 150 ft., constructed of red brick with concrete trimming, and has a wall area which is ⅔ glass.

Extending to the street walk, the first floor of the 3-story building contains the generator units and pumps, and engineers' offices, the second or mezzanine floor holds the main pipe headers, forced draft fans, ash handling equipment, and feed-water heaters, and the boilers are installed on the third floor. In the construction of this building, 5200 tons of structural steel were used, or the equivalent required to construct a modern 20-story skyscraper.

Through the large plate glass windows the pleasing interior of the engine room is visible from the street. Walls and columns are faced with white enamel brick, the floor is covered with white unglazed tile, and the crane runways and other surfaces are painted white. Supply lines and much of the valve gear are placed underneath the floor, presenting a trim and compact arrangement.

ULTIMATE CAPACITY OF 54,000-HP.

UPON STEPPING into the engine room the visitor is favorably impressed by the spacious arrangement of the large composite gas-steam engines which drive the Crocker-Wheeler direct current generators. Four of the present units in operation are rated at 6000 hp. each, and one at 5000 hp. Another 6000-hp. unit is now being erected and 3 more of the same size are under construction and will be placed in a proposed 150-ft. addition to the engine room. These units combined with a 1500-hp. steam engine already installed, give an ultimate total prime-mover capacity of 54,000 hp.

Arranged similar to a cross-compound steam engine, the standard composite gas-steam engine has tandem producer-gas engine cylinders on one side of the generator and tandem compound steam engine cylinders on the other side. The gas engine cylinders are 42 by 72-in. and operate on the 4-cycle, double-acting principle. Steam engine cylinders of the 6000-hp. units are 36 and 68 by 72-in., while those of the 5000-hp. unit are 30 and 56 by 72-in., the speeds being 80 and 85 r.p.m. respectively.

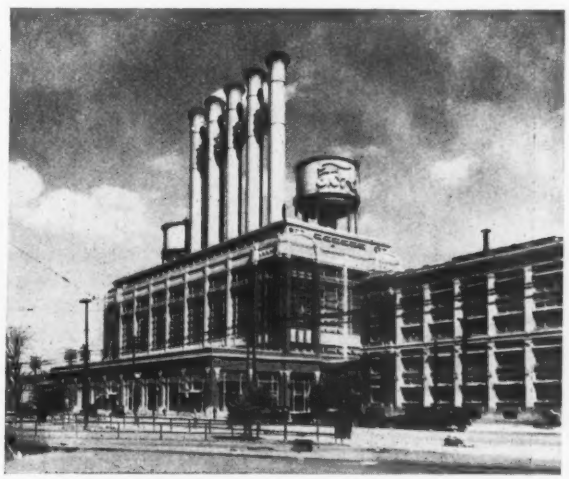


FIG. 1. EXTERIOR VIEW OF FORD POWER PLANT

As the main bed, the housings, the distance pieces, and the rail-rod supports are virtually alike, the steam and gas sides of the composite engine are quite similar in appearance. The valve gear of each side is operated by a solid lay shaft, 8 in. in diameter, which is driven from the main shaft by spiral gears with a 2 to 1 ratio.

Steam at 175 lb. pressure, superheated to 600 deg. F. is delivered through a 12-in. line to the high pressure cylinder of the steam engine side through poppet valves in the bottom of the cylinder. Two eccentrics on the lay shaft are placed at each end of the cylinder, one for the steam and the other for the exhaust valve. Each eccentric operates the valve by means of a bell crank underneath the floor connected by a reach rod and lever to a wiper cam through a governor-controlled latch.

Exhaust steam from the high-pressure cylinder enters a superheating receiver which obtains its heat from the exhaust of the gas engine. Having a shell 18 ft. long with a 7-ft. 9-in. diameter, which is lined with fire brick, the receiver contains 130 Foster superheating tubes, 10 ft. 9 in. long with a 2-in. outside diameter. Each tube or element contains a ¾-in. core in order that the steam may be exposed to the hot gases in their cylindrical layers. After leaving the receiver the hot gases pass to the waste gas feed-water heater and thence to the stacks. A shunt connection in this line heats the gas jacket of the high-pressure cylinder.

Corliss valves are employed on the low-pressure cylinder, operation being secured from 2 eccentrics on the layshaft, one actuating both steam valves through a bell crank, a vertical rod connecting with an arm on the valve stem, and a reach rod to the valve gear on the opposite end of the cylinder, as shown in Fig. 3. Exhaust valves are operated by the other eccentric through a bell crank to a wristplate, a reach rod extending in either direction to an arm of the exhaust valve stem.

From the low-pressure cylinder exhaust steam passes to a Wheeler surface condenser located in the basement, an atmospheric relief being provided from the condenser to the gas engine exhaust. Circulating water is drawn from the city mains and re-cooled by means of 5 spray ponds on the roof of an adjacent building, each pond having 216 Spray Engineering Co. nozzles. Against an average head of 20 lb., the water is circulated by one of 2 Hamilton cross-compound crank-and-flywheel pumping engines, 32 and 60 by 48-in. At a normal speed of 27 r.p.m. the pump can deliver 14,700,000 gal. of water per 24 hr. against a head of 125 lb., which is the required fire-service pressure.

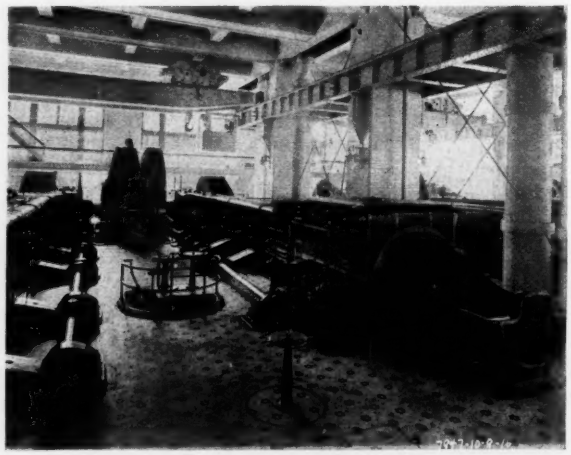


FIG. 3. 6000-HP. UNIT WITH STEAM CYLINDERS AT THE RIGHT

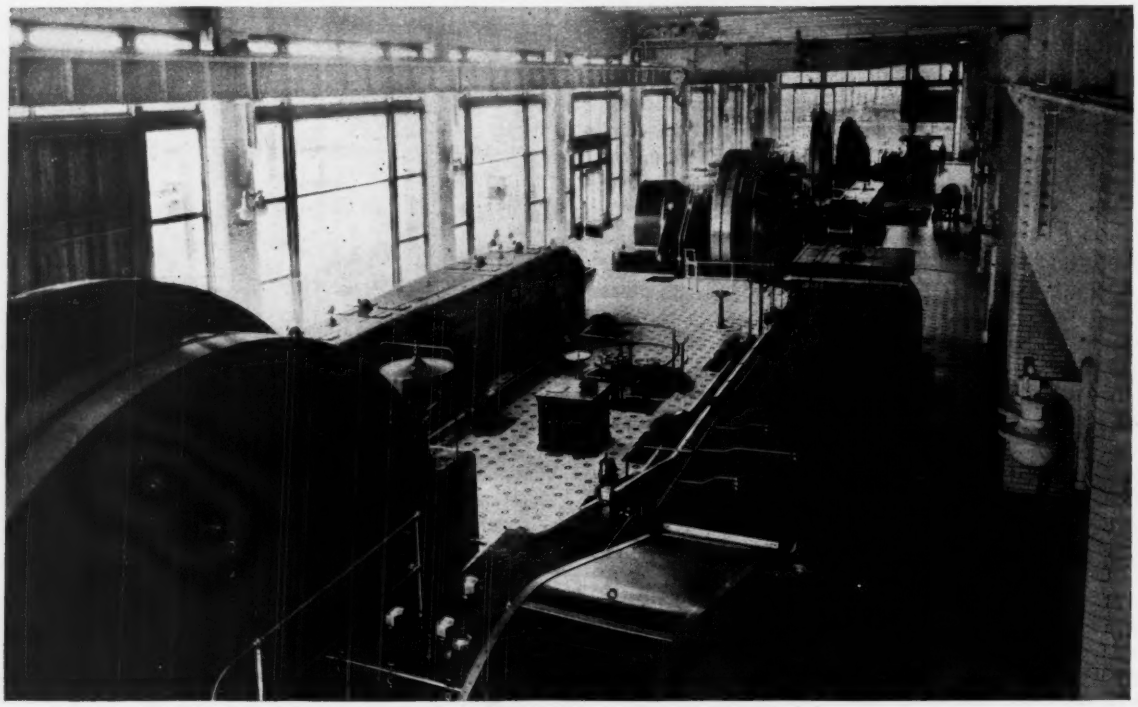


FIG. 2. PORTION OF ENGINE ROOM

Cooling Water for Gas Engine

As previously stated, the gas engine side of the unit has 2 double-acting cylinders, each formed in 3 sections consisting of 2 head housings and a barrel. To cool the heads and prevent pre-ignition, cooling water circulates first through the heads and housings at each end, and then passes through the barrel into the overflow.

Piston rods are 13 in. in diameter and have a 7½-in. bore, which contains a 3-in. tube. Cooling water for the pistons and rods is drawn through a telescopic rod at the intermediate crosshead and flows to the outer end through the 3-in. tube, where it is forced through the interior of the piston by a baffle or dam; then returns through the annular space between the rod and the tube to the intermediate crosshead where it is discharged through a second telescopic rod.

Gas Engine Ignition

Make-and-break ignition is supplied from duplicate storage battery systems, 2 igniters being provided on each side at both ends of the cylinder, making a total of 8. Each set of 4 igniters draws current from its

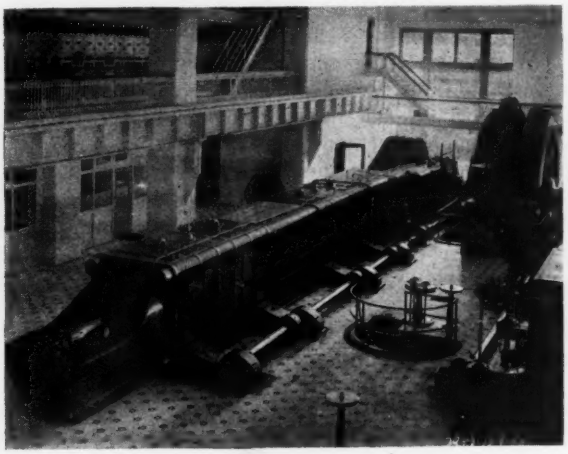


FIG. 4. GAS ENGINE SIDE OF A UNIT AND PORTION OF SWITCHBOARD

battery through a 3-wire system, the neutral being grounded to the engine frame, the positive wire connecting to one igniter and the negative to the other.

Current is distributed by timers mounted on a pedestal and operated by spiral gears from the layshaft. Placed at the top of the pedestal is a safety governor which rises with an increase in speed, and when a predetermined limit is reached, opens the ignition circuits by breaking mercury contacts. Ignition current is also automatically interrupted, when the generator circuit opens, by a switch operating with the circuit breaker. A third break in the line may be made by the operator at the control board.

Control Board for Engines

Located between the gas and steam engines is a control stand which is equipped with handwheels to control ignition, the mixture of air and gas, and the meters for the ignition circuits and ammeters for the generator circuit, it contains a signal system connected to the switchboard, which with colored lights, under push-button control, indicates the engine operation desired. A white light glows when the unit is running, a green light is an order to increase the load, an amber light calls for a reduction in load, and a red light is the signal for a shut-down.

Three floor stands are also provided—one operating the main steam throttle, one controlling the gas main, and one operating the atmospheric relief valve on the condenser.

Jahns Governor for Regulation

Mounted upon a box base and placed between the 2 engines and in front of the generator, is a Jahns governor, driven from the crankshaft by 3 independent rope drives. Both the gas and steam engines have connections to the governor; but up to normal speed there is no action on the gas engine, so that the steam engine takes all the regulation to meet fluctuation in load. At speeds above normal, the governor throttles the supply of gas and air to the gas engine, and in the event of ignition or gas trouble, the load is automatically shifted to the steam side which at late cutoff can handle the entire demand.

These combination gas-steam engines were built by the Hooven-Owens-Rentschler Co., from designs furnished by the Ford Motor Co. engineers. Photographs of this plant are used through the courtesy of the Ford Motor Co.

A Small Diesel Engine

What is believed to be the smallest internal combustion engine of the pure Diesel type has recently been completed by the Fulton Mfg. Co., Erie, Pa. It is a 90-hp. six cylinder unit and was installed in a boat that will be used by the Government in the vicinity of Wilmington, N. C. A two-stage air compressor located on the forward end of the crankcase supplies the air pressure for starting and for fuel injection. From the compressor the air is led to three steel bottles, one of which is employed to supply the injection air that is led to the injectors located on top of each cylinder. The surplus air is stored in the other two steel bottles for starting. Individual fuel pumps are provided for each cylinder. In this way, if anything should happen to cripple one of the cylinders or the pumps it would be possible for the cylinder affected to be cut out and the engine run on the remaining cylinders. The flywheel is located at the after end of the engine instead of forward, this arrangement, it is pointed out, taking all unnecessary strain off the flywheel. In a test made of the engine it developed 100 b.hp. at a speed of 400 r.p.m. instead of the 90 b.hp. guaranteed. The consumption of fuel oil per brake horsepower per hour at the rated speed of 400 r.p.m. was 0.53 lb. instead of 0.55 lb.

Packing between a cylinder head and the cylinder should be thin, the thinner the better. Thick packing is more likely to blow out, and the additional thickness unnecessarily increases the clearance in the cylinder. —Refrigerating World.

Tungsten points are so hard that a file must be moistened with oil to cut them.—The Gas Engine.

Meeting the High Price of Coal

SUPPLEMENTING STEAM PLANT EQUIPMENT WITH A CRUDE OIL ENGINE RESULTS IN CONSIDERABLE REDUCTION IN OPERAING COSTS

ABOUT a year ago the writer saw the handwriting on the wall, that is, the increasing cost of coal and the possibility of its going much higher. With this in mind, the situation was studied and various motive powers were considered to take the place of the steam apparatus used. The power plant served both an electric and water system, furnishing electricity for lighting and pumping the water for fire protection. The pumping is done principally with electrically driven pumps, although one large steam pump is used. Being much more economical than the steam pump, the motor-driven pump is employed to do practically all of the pumping, even though the plant is steam-operated.

In the study which was made it became obvious that the only practical way out of the situation would be to use oil instead of coal. However, the price of oil delivered precluded the use of oil burners under the boilers. Therefore it was decided to purchase an oil engine, a

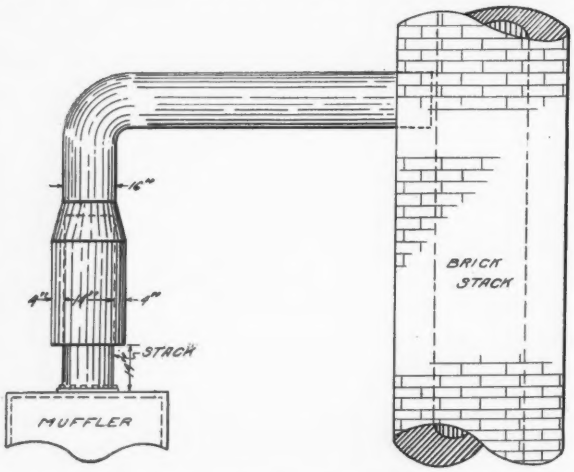


FIG. 1. METHOD OF CONNECTING ENGINE EXHAUST WITH OLD BRICK STACK TO REDUCE NOISE

125-kv.a., direct-connected generator with belt-connected exciter being selected. While arguments have been advanced that 4-stroke-cycle engines are more economical in fuel and lubricating oil on light loads, the 2-stroke-cycle type was chosen, as it was considered best for small installations and had the additional advantage that it could be started quickly and would emit very little smoke from its exhaust. Among other reasons for selecting the 2-stroke-cycle engine are the following: Reliability, fewer parts to get out of order and repair, relatively small attention required, ability to run for a long period without stopping (which does not seem to be possible with the high-compression type), and possibility of employing inexpensive labor without sacrificing economy of operation.

The engine selected is a 3-cylinder, vertical, 2-stroke-cycle, hot-ball, ignition-type Mietz engine. The cooling water is evaporated into steam in passing through the engine jacket and is allowed to enter the cylinder with the explosive mixture and pass out with the exhaust gases. This process helps to keep the cylinder walls and piston well lubricated, eliminates the necessity of using a large amount of cooling water, prevents reduction in efficiency due to using excess cooling water, and makes tanks and a complex circulating water system unnecessary. Moreover, the cylinder temperature is maintained constant under all load conditions so that the engine can operate at its highest efficiency.

The fuel oil is injected into the cylinders by an injection pump through a simple distributor. The governor acts directly on the injection pump regulating the speed by alternating the amount of fuel used. Regulation as good as is usually secured with the best steam engine is being obtained. Unlike the steam-engine-driven generator which the oil-engine set replaces, the latter can be paralleled with the other steam equipment readily, and operated in multiple indefinitely. By retaining one complete steam set it is now possible to operate with either steam or oil and give 24 hr. service.

In supplementing the steam equipment with oil-engine apparatus several problems arose. Probably the most important one was how to maintain continuous service should the engine stop suddenly, as it was not desirable to bank fires under the boilers. This difficulty was overcome by water-jacketing the exhaust pipes from the oil engine and circulating the water through one of the 125-hp. boilers. In order to do this the exhaust pipe from each cylinder was extended 8 ft. and a larger-sized pipe slipped over it and secured concentrically therewith by packing glands at each end. The arrangement employed is shown in an accompanying illustration.

With this provision it is possible to maintain the water in the boiler at or near the boiling point, so that with the firebox filled with wood and oily waste, steam can be raised in 30 to 40 min. This arrangement also eliminates the expenditure ordinarily involved when fuel must be used for banking fires, and the heat ordinarily lost through the engine exhaust is utilized. Furthermore, the water surrounding the exhaust pipe tends to cool and contract the hot gases, thereby reducing the back pressure considerably.

Eliminating smoke and noise from the exhaust was another problem of considerable importance. While a large cast-iron muffler was furnished with the engine and eliminated most of the noise on light load, it became noticeable on quiet nights when the engine was operated at full load. In order to avoid this difficulty, the engine exhaust was connected with an old brick stack which formerly served two small boilers (one of which has been taken out), thus requiring the exhaust gases to pass up the stack before expanding completely, and also deadening the noise almost entirely. So that this arrangement would not increase the back pressure, an injector was constructed between the muffler and the pipe leading to the stack. This arrangement produced very satisfactory results. Occasionally the soot is allowed to burn out even up to the brick stack, a continuous occurrence of

this kind being prevented normally by admitting water to the cast-iron muffler.

The oil used in this plant is received by gravity from tank cars through a 2300-ft. pipe. With average temperatures (temperature affecting the viscosity of oil), a car can be unloaded in 5 hr., the elevation of the railroad above the tanks being 50 ft.

The installation has proved entirely satisfactory from every angle. As far as economy is concerned, the saving over steam operation—that is, the saving in coal—is quite an inducement to use the oil engines even when coal is at normal prices. When abnormal prevail, as in the last few months, the saving is enormous. Even if the price demanded for coal could be paid, it would have often been difficult to get a sufficient supply of fuel.

With coal at the average price of $4 a ton, the steam plant burns $20 worth of fuel in 24 hr. Added to this expense is the labor cost of employing one fireman at $2 a day. The general upkeep expense is estimated at $200 per year, not including natural wear and depreciation of the plant as a whole. Included in this expense are such items as firebrick, labor, packing, gaskets and various small items.

With the oil-engine set the average upkeep expense is $100 per year. In fact, this is liberal, for it is difficult

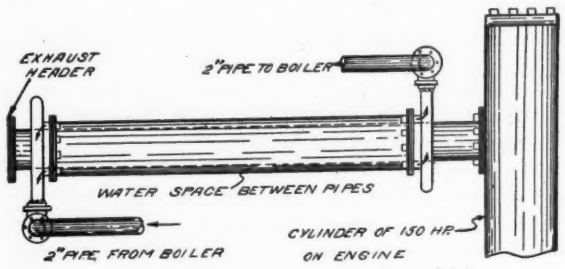


FIG. 2. WATER CIRCULATED AROUND EXHAUST PIPE TO REDUCE BACK PRESSURE AND AVOID NEED TO BANK FIRES

to foresee where $25 can be spent on upkeep, since no packing is required except for the gaskets, cylinder heads and plates, about the only replacements necessary being for small items such as broken pipe connections or petcocks. The average fuel consumption of the oil engine is 140 gal. per day. Thus with oil at 6c per gallon delivered, the fuel cost is $8.40 per day, in contrast with $20 per day for coal. Operating with 12-hr. shifts, two men are required in the plant.

The oil engine installed costs more than a corresponding steam engine and generator and about the same as a 4-stroke-cycle engine of the high-compression type. The low upkeep expense and the reliability of the engine more than offsets the extra fuel consumed, a 2-stroke-cycle engine being somewhat less efficient than a 4-stroke-cycle engine.

Extraordinary conditions in the coal market have made this installation a most profitable venture. Instead of saving $14 per day as would have been the case under normal conditions, about $32 per day is saved, this amount being based on figures for 5 mo.

The adoption of oil-engine drive was not prompted alone by the unusual condition in the coal market. By watching conditions and estimating the probable duration of the war it was figured that the railroads would be deluged with work, causing labor to be high and scarce at the mines, and that for several years at least it would be difficult to fill coal bins at any price.

Although the results obtained lead the writer to believe that the Mietz engine direct-connected to a Westinghouse generator is the most reliable set for small stations, it is probable that some other type of prime mover might prove better, because of the fuel saving permitted, if a unit as large as 800 or 1000 hp. had to be installed. The success obtained with this installation indicates that more small plants, either municipal or privately owned, would do well to consider using oil engines, even where they do not require them as auxiliaries to large powers. This is particularly true in small plants, which do not have the trained forces of larger ones for studying operating problems.—Electrical World.

Money Orders and Parcel Post for U. S. Expeditionary Forces

DIRECTIONS for letter mail were given in the issue of Aug. 1, p. 619. Further instructions are that money orders should be made payable at "U. S. Army Postal Service," and the name of the payee should be followed by his regiment, company and other organization to which he belongs.

Parcels of fourth-class or domestic parcel post matter may now be sent, not exceeding 20 lb. in weight, to the expeditionary forces. The rate is 12 cents for each 1 lb. or fraction; the parcels cannot be registered or sent C. O. D. The address should be as follows: 1—Name of addressee; 2—official designation of unit to which he belongs; 3—"American Expeditionary Forces." Each parcel must bear the name and address of the sender in the upper left-hand corner on the address side. All parcels must be securely packed and wrapped, but not sealed, and have postage fully prepaid.

Method of Keeping Gaskets Tight

WE HAVE a 6 and 4-in. steam line about 100 ft. long carrying steam to one turbine and one reciprocating pump. We have had trouble in keeping the gaskets tight on this line, probably owing to our over-night shut-down, and the resultant expansion and contraction. Sheet packing was not a success. Copper gaskets did not solve our problem. We replaced them repeatedly.

At last we hit on tubular gasket gum, such as is ordinarily used for manhole plates, and it is a success. We put in a circular gasket of this material just inside of the bolts and tighten well, draw it up again when warm, and go over the same several times for a few days. I am glad to say that we have a tight steam line, which is a matter of great satisfaction. The material is cheap; there is no waste in cutting and its use deserves to be extended.

We have found tar paper or roofing very good for water; as far as we can see, it is as good as high-priced sheet rubber packing. H. L. SHERMAN.

S. E. VANCE has been appointed Washington District manager for Warren Webster & Co., with offices at 301 Southern Bldg., Washington, D. C.

LETTERS DIRECT FROM THE PLANT

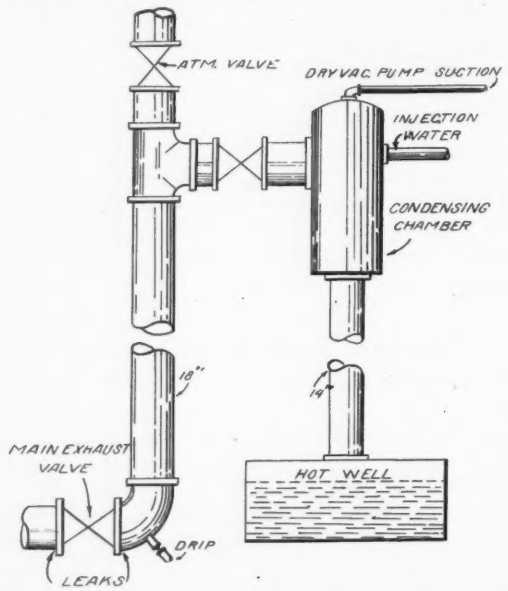
Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Wrecks Prevented by Inspection

THIS INCIDENT HAPPENED in a condensing plant consisting of a tandem compound Nordberg engine and a single Corliss engine, also two small high-speed engines running noncondensing.

The high-speed engines were running this certain afternoon when the engineer came in at 3 o'clock to take his shift.

He was told by the engineer who went off duty that the condensing apparatus was working O.K. and to start the main units as soon as possible. After getting into his overalls he looked around the engine room and apparently everything was all right, the vacuum gage showing the usual amount of vacuum. Not wanting to start up the engines before he was absolutely sure, he



CONDENSER PIPING SHOWING LOCATION OF LEAKS

went down in the basement. He found the dry vacuum pump and the circulating pump O.K. Walking over toward the hot-well, he saw water dripping down from the flanges on both sides of the main exhaust valve. Looking at the trap on the drip from the exhaust pipe, he found it not working. Opening the bypass of the trap, he saw a stream of water coming out. He shut down his dry-vacuum and the circulating pump and it took an hour to drain the water out from the exhaust pipe and low-pressure cylinder. The only way that we could account for all this water in the condenser is that the main throttle valve and the valves on the engines were leaking and the condensed steam accumulated in the exhaust pipe.

In another case, the plant consisted of three high-speed engines running noncondensing and two vertical fire-tube boilers, using a closed heater for the feed water.

The largest engine and both boilers were running when the low water alarm whistle started to blow and at the same time the fireman came in and told the engineer that he could not get any water into the boilers.

The feed water was taken from a receiver that was supplied from the city, having two connections, one 45 and one 90 lb. pressure, the 45-lb. connection being used this day. Looking at the receiver and the glass not showing any water, he thought the 45-lb. connection for some reason or other was shut off from the street. He opened the 90-lb. connection. By this time, the light began to get dim. Going into the engine room, he found 20-lb. pressure on the back pressure gage. Then guessing the trouble, he went over the heater, and hearing the water going into it, he knew a coil had burst. Then he told the fireman to bypass the feed water, while he himself opened all the drips and bypasses on the heater and exhaust pipe, and it did not take long to get water into the boilers and the engine up to speed.

We must have had at least 40 ft. of water in the exhaust pipe when the back-pressure gage showed 20 lb., and he would have had a wrecked engine if he had shut his engine down when he found the trouble, as the steam pressure from the engines was keeping the water away from the cylinder. C. M.

Trouble with Corliss Valve

RECENTLY I had a somewhat unusual though not unprecedented experience with the valve gear of a Corliss engine.

The unit, which in conjunction with a smaller one, is used for driving generators, has been in operation for about 12 yr.

Having a new night man, I was not worried particularly when he called me about 7:30 one evening and said that the crank end dashpot was failing to go down.

I assumed that, for some reason or other, it was cushioning too much, or that the steam valves were dry, and his unfamiliarity was causing him undue uneasiness.

After offering a few suggestions, however, I decided to go down and see what the trouble was.

Before I got there the steam valve gear on that end was practically wrecked. The steam valve crank was broken in two pieces, the dashpot rod was broken right below the brass head, the radial rod was bent, the lug for radial rod on wristplate was sprung, the crab-claw hook was also sprung and the valve bonnet loose on the steam chest.

My first thought after looking at it was that the valve

had either jammed something in the port or that the stem was stuck in the bonnet.

I had, several years before, spent a whole day, together with 2 others, in removing a "frozen" valve stem from the bonnet of an engine at another place, so that this flashed into my mind at once.

Sure enough, I put a Stillson on the end of the stem and couldn't budge it.

We took off the bonnet, and putting it on some wooden blocks, tried to drive it out by means of a soft piece of brass and an 8-lb. sledge. It went about 1/16 in. with about 20 blows of the sledge. The idea then struck me that since steel has a greater coefficient of expansion than cast iron, it would likewise have a greater coefficient of contraction; therefore we submerged it in the brine tank until thoroughly cold, and the steel stem contracting slightly more than the cast-iron bonnet, we were enabled to drive it out by dint of much heavy hammering and driving back and forth.

When removed, it was as I suspected, part of the stem had joined the bonnet and part of the bonnet had joined the stem; however, it was only in a place about 1 in. long. The one I mentioned having spent the day on was "frozen" its entire length, but was a new stem and bonnet, while this stem and bonnet had been running 5 yr.

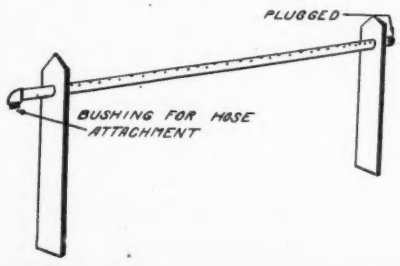
In the former instance, however, the engineer had had presence of mind enough to disengage the reach rod from the wristplate, thereby saving the valve gear.

I bored out the bonnet, taking a very light cut, and also ran the tool over the valve stem where it had been "frozen," and as I happened to have a spare valve crank on hand, by having the dashpot rod welded, I finally got her O. K. about next day at noon.

The cause was lack of sufficient oil, since the bonnet was dry as a bone. R. B.

Homemade Sprinkler for Garden

SINCE A great many engineers are devoting their spare moments to the care of vegetable gardens in order to combat the high cost of living, they might be interested in the simple device we are using for thoroughly watering the patch during dry spells and at times when the force is too busy to do the watering by hand.



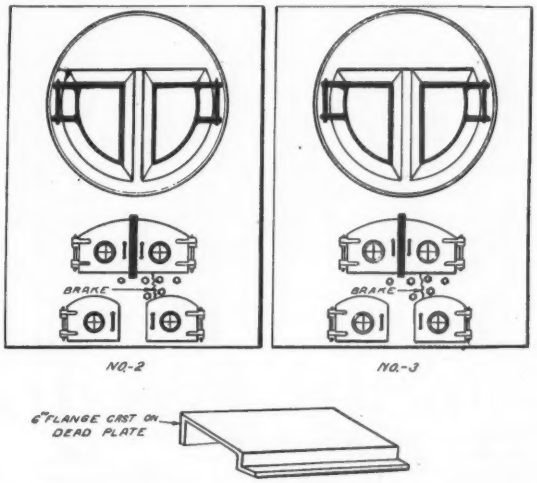
PERFORATED PIPE USED TO SPRINKLE GARDEN

About 12 to 15 ft. apart we have set up two wooden standards for supporting a 1-in. pipe sufficiently long to span the patch, the top of which pipe has been drilled with a plentiful supply of 1/8-in. holes. On the end of the distributing pipe nearest the power house is placed an elbow and then a bushing to receive a standard water hose coupling and when it is desired to water the patch the water hose is connected up. The 1/8-in. holes are all drilled in the top of the water pipe so that the water is thrown up in the air and allowed to fall gently on the ground. The fit of the pipes in the standard is also loose enough that the distributing pipe can be rotated one way or the other to compensate for any wind or breeze that might be blowing. This arrangement waters the patch more completely than is possible by hand and also allows the watering to be done very frequently because no time is lost in doing it. This scheme could also be followed out in making a portable lawn sprinkler.

M. A. SALLER.

Boiler Front Repairs

WE HAD two boilers in our plant, Nos. 2 and 3, of the full front steel setting type with their fronts broken as shown in the drawing and badly warped and out of line. Owing to the extreme high cost of material, the lower halves of these fronts were out of reason in price, so I began to figure my cheapest way out, and finally worked out the following scheme, then going to our local foundry and being able to locate a pattern that would answer, with a few slight changes, I decided to do the job in this manner: I had two dead plates cast, as illustrated. Boilers 2 and 3 were cut out and our load adjusted to suit the capacity of No. 1. The



BROKEN BOILER FRONTS AND PLATE USED IN MAKING REPAIR

front brickwork was then torn out of No. 2 and the front jacked back into place. Then I put the force on the middle wall and rushed it up. The next morning No. 3 was put back into service and operations were resumed as usual. Then I proceeded to finish up No. 2. The dead plate was put into place by drilling through front and dead plate flange and bolting them tightly, as shown in the sketch.

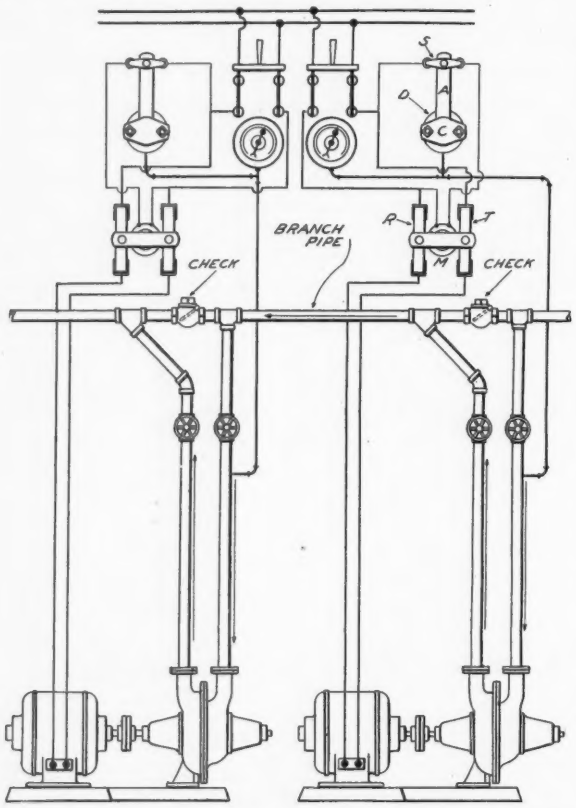
The furnace work was completed. The old front was treated to a good coat of paint and now looks as good as a new front. I then put her back into service and No. 3 was given the same process. This job, at the present price of material, saved the company over $200.

A. G. CROTHERS.

Boosting Water Pressure

THE WATER SUPPLY for a very commodious mansion house belonging to a prominent club in our town became a bother to the management on account of its irregularity. The building is four stories high. The water is taken from the street main.

In the beginning, the pressure in the main sufficed to send an abundance of water to all parts of the establishment at all hours of the day, whatever the demand might be; but later on, the erection on a considerable scale of other water-consuming enterprises in the neighborhood caused the pressure to drop to a figure that was barely sufficient to send the water to the top floor when the quantity consumed throughout the building was at its smallest, but which was altogether inadequate when the minimum consumption was much exceeded.



ARRANGEMENTS OF PUMPS AND PIPING FOR BOOSTING WATER PRESSURE IN TWO STAGES

To correct this, the management decided to install an automatically operated, electrically driven, centrifugal pumping outfit to serve as a booster. Instead of putting in a single unit for this purpose, however, it was planned to install two, of equal size, and arranged in tandem, thus economizing on the power consumed and also securing a degree of flexibility in the boosting. The drawing herewith is a diagram of the arrangement.

When the pressure in the branch leading from the street main drops to 45 lb., as indicated by the pressure gages, the tension imparted to a helical spring by the adjustable cap, C, overcomes the pressure of the water on the diaphragm, D, and causes the diaphragm to buckle the opposite way, thus operating the arm, A, to close the switch, S, for the passage of current through the magnetizing coil, M, which closes the circuit for the motor current through switches R and T. When the extra draft on the water service ceases, and the pressure is restored to normal, the tension of the diaphragm spring is overcome and the connection through switch S is broken, thus demagnetizing the coil, M, and releasing switches R and T. If the system is being drained of water faster than the one pump can supply it, however, and the pressure continues to fall, the other unit will go into action, the pressure to which the automatic switching device for this unit responds being 43 lb. The purpose of the swinging check valves is obvious.

Each pump boosts the pressure 20 lb. Thus, if the normal supply pressure drops to about 23 lb., the pump shown at the right-hand in the diagram will give a pressure of 43 lb. on its discharge side; but at this pressure, the pump at the left hand will go into action, so that the final discharge pressure will be about 63 lb. An increase of about 5 lb. above this pressure will cause the second pump to drop out, and when the discharge from the first pump reaches 70 lb. pressure, corresponding to about 50 lb. on its suction side, this pump will also drop out.

A. J. DIXON.

Pounding of the Engine

EVERY ENGINEER at some time meets with the obnoxious pounding of the engine, in some place, he knows not where, and it requires great perseverance to overcome some of these mysterious pounds. One contributor, in a recent issue, speaks of a pound which apparently was in the crosshead, but proved to be in the eccentric, which shows how elusive some of these engine pounds really are.

The writer was called to the plant one evening about 8 o'clock. The night engineer had stopped the engine to see what was loose. Nothing was wrong with either of the crank or crosshead pins, so he started the 13 by 18 by 24-in. tandem compound engine up again. It ran along with little noise, and as I entered the room there was very little pound noticeable, and as the engineer had looked the engine over, desiring to avoid further delay, I decided to wait until morning to shut down again.

When I arrived at the plant the engine was hammering quite loudly. When it had been stopped I put the wrench on the check nut on the piston rod and found it loose; the rod had unscrewed from the crosshead about ¼ of a turn and the thread, being an easy fit, was being rapidly pounded out in the crosshead. How long this could continue can only be conjectured, as the clearance between the cylinder head and piston with the rod backed out that distance must have been very small. I put the trammel points on the rod and crosshead and it measured close to ⅛ in.

On a 500-hp. Armington-Sims cross compound engine a pound developed which could not be located and the head was taken off the high-pressure cylinder. The piston was held onto the rod by a nut and cotter pin through the nut and rod end. By the use of thickness feelers, it was found the nut did not draw up on the piston by about 1/32 in., and to tighten the nut the cotter pin could not pass through the end of the rod. So two steel washers of sheet steel were cut and placed

under the nut, the nut screwed up tight and the cotter pin put in. There was no more pound.

A pound in the crosshead pin may be caused by one of several conditions. The nut which holds the pin in the crosshead may have come loose and the wristpin come loose in the crosshead, causing a heavy pound; or the brasses may be bound tight against each other on the edges; or if the crosshead pin is completely round when put in, it may have become worn out of true enough to allow the brasses, if keyed up tight, to pinch the pin on the edges when the crank is passing the 90-deg. point of the revolution on each stroke. When this is the case, by loosening a crosshead shoe, even slightly, the crosshead will slap or pound the guide at the instant the brasses pinch the crosshead pin. If the crosshead shoes are not kept properly adjusted, this hammer or slap of the crosshead will occur at intermittent intervals. Also with loose crosshead shoes the brasses are apt to wear out of a true parallel fit between the crosshead pin and the end of the rod. Then, if it is keyed up snug, the crosshead will develop a sidewise pound at each end of the strke; or if the crank shaft is out of line with the cylinder and the crankpin brasses keyed up tight with the crosshead shoes loose, the crosshead will have the sidewise pound just the same. To prove this, disconnect the connecting rod from the crankpin and key up tight on the crosshead pin and see how the end of the rod points. If the brasses in the crosshead end are out of true, the connecting rod will spring to one side at the crankpin, and if the crank shaft is out of line, the rod will spring sidewise at the crosshead at each end of the stroke.

To prevent the crosshead brasses from pinching the pin, the pin should be taken out and turned ¼ way around if the pin is round, or as some engine builders make a crosshead pin flat on each side, it is only necessary to rub up the corners a little with a very smooth file and replace the pin. The brasses seldom pinch where a flat crosshead pin is used. If the engine is in line and none of the above mentioned troubles cause pounding, and it is neither brass bound or key or wedge bound, but still seems to pound in the pins, it is generally from lack of compression. In this case, it is desirable to apply the indicator before making any change in the valve setting. It may mean only a slight change in adjustment on the right and left screw of the exhaust connection from the wristplate to the valve crank would be required to stop the pound or often a slight turn of the valve stem on a high speed engine is sufficient to stop the hammer. The main bearing often pounds when babbit gets worn with no adjustment to take up the wear or when quarter boxes become loose; but this is more easily detected by sound or by inspection of the air gap between the armature and pole pieces of direct connected dynamos. In some cases, the eccentric on the main shaft may have to be advanced a trifle to get more compression. Insufficient compression with slightly loose quarter boxes will give two pounds at the same time which are hard to locate; one in the quarter boxes and one at the cylinder head and as many more sounds as there are loose pins or nuts, keys or wedges to wear or work loose. An angle compound engine on account of one cylinder being higher than the other, or any high speed compound engine is apt to take much water in the low-pressure cylinder when foaming or priming of the boilers occurs, often because the receiver cannot drain this water out as rapidly as it enters into the receiver, and it passes to the low-pressure cylinder in great slugs or quantities, and if the engine runs condensing, so much the better. The water may be mostly drawn out of the cylinder from the front side of the piston by the vacuum, thus preventing the engine being wrecked or the piston rod being stretched. Where the clearance between the piston and cylinder head is small, it requires very little stretch to make the piston strike the head enough to cause an annoying pound.

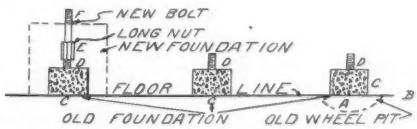
The shimming up of the brasses of the connecting rod with different forms of adjustments is often apt to lengthen the rod enough to cause the piston to strike the head of the cylinder. Then, if the adjustments are such as to shorten the length of the rod, the piston hits the crank end of the cylinder and the stretching action again occurs; or if the engineer escaped by a small margin in making adjustment, a small amount of water would finish the job of pounding and stretching the rod. Much depends on the make and design of the engine.

R. A. Cultra.

Care of Wooden Gear Teeth; Raising Foundation

About a year ago, I asked, through Power Plant Engineering, advice on care of wood teeth for mortise gear. Your advice and that of correspondents, through the paper differed, so through experiment I tried my own idea. This gear was in a dry and dusty place (sugar beet factory). Twice a week I put on tallow, which was not melted, but soft, with a paddle. It was a success, showing but little wear after 65 days. If the gear is in a damp place, it is not necessary to use anything.

The diagram illustrates raising a piece of machinery, using the old foundation and holding down bolts. We wished to raise our gas pump 10 in. higher, so as to get the flywheel out of a wheel pit, but we did not wish to cut down in the cement foundation for new holding-down bolts.



METHOD OF BUILDING UP FOUNDATION

The superintendent, chief, and myself, finally hit on the following: The bolts being 1⅛-in. stock, we found a piece of 1 15/16-in. shafting, cut it into lengths of 3 in., drilled a hole through the center and tapped it out for 1⅛-in. bolts. We made up studs 10 in. long, being threaded, of course, on both ends. We screwed the 3-in. piece of shafting, E, onto the old holding-down bolts, again screwing the new studs, F, into E, thus extending our holding-down bolts the desired height. We screwed the bolts so they would meet end to end in the middle of shaft E.

Roy Stahl.

An abnormal consumption of lubricating oil in the gas engine may be caused by: A leak in the crankcase, or in the end bearings of the motor; by the burning of the oil in the combustion chamber, which will be indicated by bluish smoke issuing from the exhaust pipe. —Gas Power.

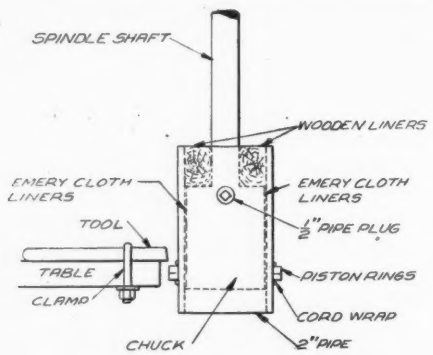
Successful Kinks From The Plant

For Saving Time, Work and Trouble

Making Piston Rings on a Drill Press

HAVING two broken piston rings in my 2½ by 4-in. horizontal steam engine, being unable to have any made locally and wishing to avoid delays, I undertook their production myself with the following tools at hand: Files, emery cloth, vise, hacksaw, grindstone, pipe, pipe tools and drill press.

Having obtained a suitable piece of metal, I finished the bore first, using a piece of metal slightly larger than the two rings. Having completed the bore, I then obtained a piece of standard 2-in. pipe 6 in. long. To the outside surface of this pipe, near one end, I applied some McCormack iron glue. I then slid the metal ring over the end of the pipe and well into the glue and wrapped some light linen cord on each side of the ring. After the glue became set, I placed the pipe in the vise and sawed the ring nearly through all the way around, thus making two rings. I then filed both rings down to



USING DRILL PRESS AS LATHE

approximate diameter. In the other end of the pipe I bored and tapped a standard ½-in. pipe thread about 1½ in. from the end.

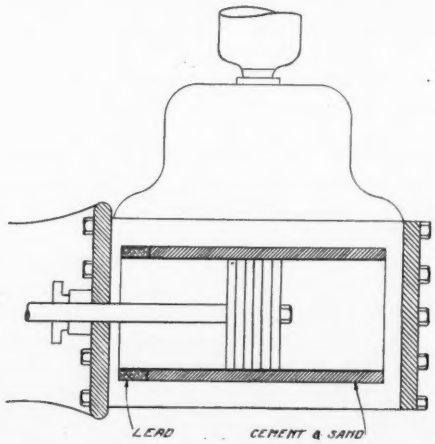
I then pasted 2 layers of emery cloth to the outside surface of the drill chuck, thus making its diameter as near 2 in. as possible. I next slid the pipe over the chuck, and up about an inch beyond the shoulder on the chuck and screwed a ½-in. pipe plug into the hole provided for this purpose, thus firmly fixing the pipe to the drill chuck. Then I carefully drove wooden wedges between the chuck shaft and the pipe, until the pipe revolved quite true. I ground a file down for a cutting tool; swinging the drill table slightly to one side, I clamped the file firmly to it. Revolving the drill spindle with one hand and feeding in the table with the other, I soon had a good rough finish on the rings, whereupon I applied hot water to the glue and removed the rings from the pipe, separated them, and glued a piece of emery cloth to a true surface, upon which I revolved the rings until the desired width, 3/32 in., was obtained.

I then glued them to the pipe again and finished to the required thickness. I then buffed them, removed the pipe to the vise, split the rings, removed them from the pipe as before, cleaned them, and put them on the piston, coated the inside walls of the cylinder with an indicator, i.e., white lead, put in the piston and revolved a few times very slowly. The piston was now removed, the rings showing a surprisingly uniform coating of white lead.

ARTHUR SCHAU.

Pump Cylinder Repair

IN MAKING some minor repairs to the water end of a boiler feed pump, "someone" carelessly left a small chisel in the working barrel and then put on the head. It is needless to say that the liner was "chewed up" beyond permanent repair. A new liner was ordered, but when it was received, it was found that the external diameter was 1½ in. too small to make a snug fit. As the old liner was hard on packing and the pump was giving very unsatisfactory service, it was decided to use the new liner, which was made tight in the following manner:



CEMENT AND LEAD USED TO FILL SPACE AROUND LINER

The old liner was removed and the new one put in place. The water end was then entirely disconnected and placed on end. The space around the liner and casting was then packed tightly with Portland cement and sand to within about 3 in. of the top, or the end next the steam cylinder. The cement near the top was then thoroughly dried with a blow-torch. The 3-in. space was then filled with hot lead, a little at a time, and calked. This was repeated until the entire space was filled.

This made the liner absolutely tight, and after several months of hard service it shows no signs of being loose.

JACK L. BALL.

Rigid Light Fixture; Lubricator Heater

INTO AN iron plate ¼ in. thick fastened to wall or ceiling by wood screws, a ⅛-in. gas pipe is screwed The other end of the pipe is screwed into the lamp socket in place of the hard rubber bushing ordinarily placed here. This device may be mounted in any position, upright or otherwise, and provides a cheap, durable, rigid fixture.

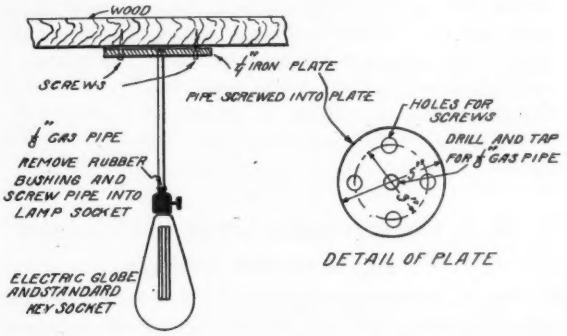

WOOD
SCREWS
¼" IRON PLATE
PIPE SCREWED INTO PLATE
HOLES FOR SCREWS
DRILL AND TAP FOR ⅛" GAS PIPE
⅛" GAS PIPE
REMOVE RUBBER BUSHING AND SCREW PIPE INTO LAMP SOCKET
ELECTRIC GLOBE AND STANDARD KEY SOCKET
DETAIL OF PLATE

FIG. 1. RIGID FIXTURE FOR ELECTRIC LIGHT

When a power house or engine room is insufficiently heated, or in places where there are machines running under conditions where housing is impractical, the oil frequently becomes clogged and will not feed properly without being warmed.

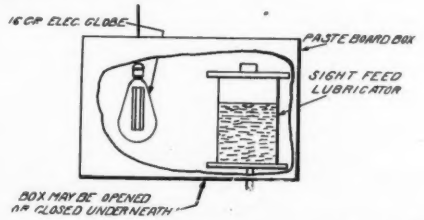


FIG. 2. METHOD OF KEEPING LUBRICATOR WARM

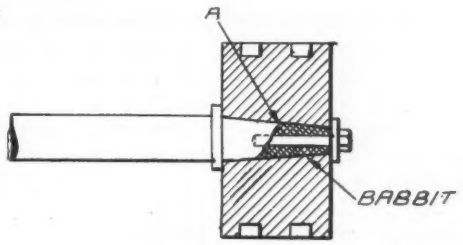
The illustrated device will eliminate this condition, besides being clean, cheap and smokeless, as compared with the open kerosene torch sometimes used for this purpose.

ROY H. POSTON.

Temporary Repair of Piston Rod

WHILE VISITING a fellow engineer in a small factory plant, and just rambling around to pick up ideas and information during my vacation, I was well repaid. Here are two kinks I picked up in this fellow's plant.

One of his small pumping engines had developed a pound until he had to shut it down and make an examination. His surmise was that the piston was loose, and this soon proved to be the trouble. The nut had worked back about half a turn. Getting a wrench and heavy hammer, he proceeded to tighten it up; but after giving a few stiff blows on the wrench, off came the end of the piston rod. It broke as shown at A in the sketch. After just a little thinking, he proceeded to make the repair shown in the illustration, without even taking the piston out of the cylinder. Getting an "Old Man," and a ratchet drill, he bolted this to one of the studs of the cylinder head, and drilled and tapped the hole for a ⅞-in. stud. Getting the stud driven in solid, he melted some babbit metal, and poured it around the stud, making not only a quick repair, but a fairly strong one. He completed the whole job in 3 hr., but did not run full working speed, being content to get along with this repair, running at reduced speed, and at once sending for a new rod.



TEMPORARY REPAIR OF BROKEN ROD

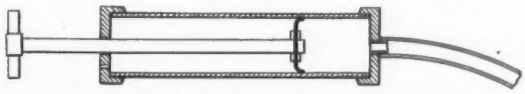
Having to rebabbit some brasses, and finding that he had no sheet brass to make shims out of, he hit upon the scheme of using some old brass tubing and piping, splitting it lengthwise, and flattening it out (first annealing it to keep from cracking). Of course, these were not so good as liners made from new sheet brass, but they helped him in time of need, and it was a clever thought.

C. H. W.

A Useful Oil Pump

ONE OF THE most useful little homemade devices we have around the plant is a small and very simple suction pump, which we have found very handy for taking oil out of bearings, oil cups, etc., as well as for removing small quantities of water or oil from other inaccessible places. We have around the plant a number of motors and machinery, as well as considerable line shafting, equipped with ring oilers, and we find this little pump of great service whenever it is desired to remove the oil from the reservoirs for inspection and cleaning.

The pump consists merely of a piece of brass tubing, 2 in. diameter, about 8 in. long, to each end of which is screwed a 2-in. cap and at the one end this cap is



PUMP FOR REMOVING SMALL QUANTITIES OF OIL FROM INACCESSIBLE PLACES

tapped to allow the passage of a ¼-in. rod, to the outer end of which is attached a handle and to the inner end of which is fastened, between 2 washers, a leather cup which fits tightly against the inner walls of the tube. The upper cap is also tapped with a small ⅛-in. hole to allow the escape of air when the plunger is being pulled back. The cap at the other end is also tapped for ¼ in. to receive a long ¼-in. nipple. To the outer end of the nipple is attached about 15 in. of ¼-in. hose which can readily be inserted in small bearings, oil cups or other inaccessible positions.

M. A. SALLER.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Removing Ammonia from Absorption System

I WOULD like to know how to proceed to remove the ammonia from the generator, the condenser, the brine cooler or the absorber of an absorption system. Is there any way in which this can be pumped out and stored in some other part of the system as you would in the case of a compression system? J. B. K.

A. In regard to the getting of ammonia out of your absorption system, this is not frequently done, but you can clear the system by the following method:

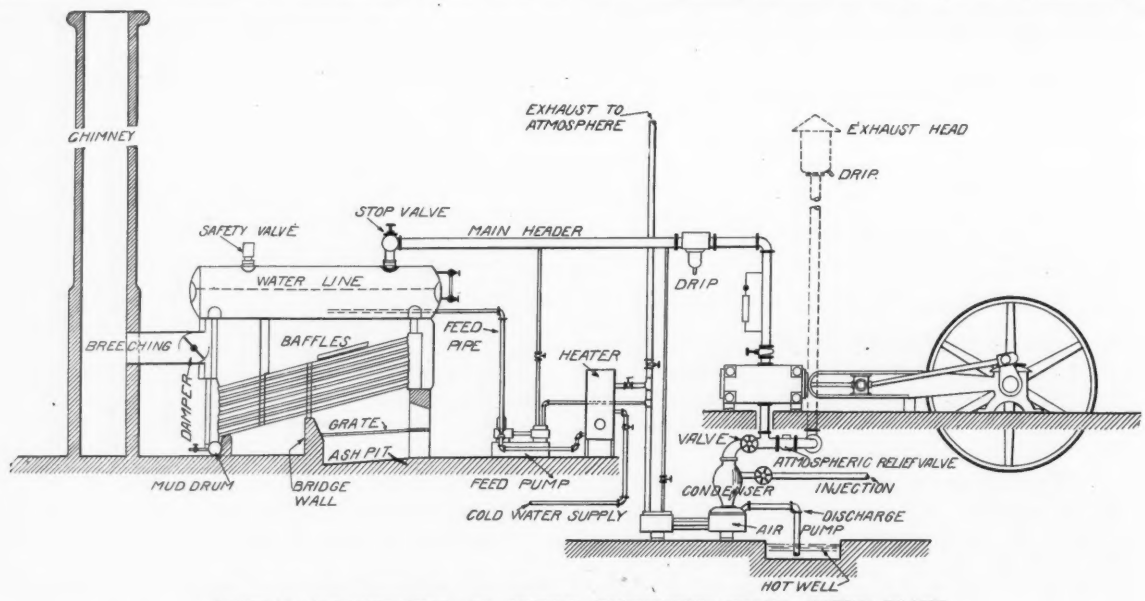
First, close off the rich liquor supply to the exchanger or equalizer, and run steam in the generator for an hour or more to get the liquor as weak as possible. Then close off the gas inlet to the condenser or rectifier, and by putting in cross-over connections so that the pump can draw from the generator and from the exchanger and deliver to the absorber, all the liquor can be pumped to the absorber.

Now, to clear the condenser of gas—first, condense all possible gas by running the condensing water over it; then, after the liquid gas is all in the receiver, and the liquor has all been pumped into the absorber, close off the connection from the condenser to the receiver, open the connection from condenser to generator, and pump out all gas possible, forcing it into the absorber. This will leave the generator, exchanger and condenser sufficiently free from gas so that they may be opened up.

Another method would be to boil out the liquor well in the generator, and then drain the weak liquor into a tank or drums, and pump all the gas into the absorber. Or, if it is desired to work on the absorber as well as the exchanger and generator, the ammonia could be shut back into the receiver and brine cooler, the liquor circulated from absorber to generator and exchanger, and boiled until all the liquor was weak, and the entire liquor system drained to a tank or drums. The ammonia gas would then be pumped out with a vacuum pump and forced into a drum. A. L. R.

U. S. Coast Artillery Corps Examination Questions and Answers

WE HAVE recently received from O. S. Romans, Fort Mills, Corregidor, P. I., a complete set of examination questions such as asked candidates for the position of master electrician, U. S. Coast Artillery Corps. The first section of this set devoted to the subject of steam engineering is published herewith, together with answers. The remaining sections on the subjects of electricity, dynamos and motors, power transmission and telephony and wireless, will appear in future issues.



GENERAL ARRANGEMENT OF SIMPLE CONDENSING STEAM POWER PLANT

1. (a) Make a pencil sketch of a simple condensing steam power plant, showing all of the necessary equipment.

A. See diagram.

1. (b) About what percentage of the total heat value of the fuel burned can be converted into useful power in such a plant? What are the various losses?

Give approximately their relative percentage values in terms of the total available heat of the fuel.

A. In a properly designed installation, about 10 to 12 per cent of the total heat value of the fuel should be available in the form of useful power.

The various heat losses are, according to Steam Power Plant Engineering, by Gebhardt, approximately as follows:

BOILER LOSSES

Loss due to falling through grates	2 per cent
Loss due to incomplete combustion	2 " "
Loss due to heat carried away in chimney gases	23 " "
Radiation and other losses	8 " "
Total	35 " "

	B. t. u.
Heat used by engines and auxiliaries (16 lb. of steam per indicated horsepower-hour, pressure 150 lb., feed water 210 deg. F.)	16,250
Engine and generator friction, 5 per cent	812
Leakage, radiation, etc., 2 per cent	325
Total	17,387
Heat equivalent to 1 electrical horsepower	2,545

	Per cent
Percentage of heat value of steam converted into electrical energy	14.7
Percentage of heat value of fuel converted into electrical energy, $(2545 \times 0.65) \div 17,387$	9.5

1 (c). What is meant by combustion? In commercial practice, what are the requirements of perfect combustion? What are the 2 principal products of combustion?

A. When used in connection with fuel, the term combustion refers to the chemical union of the combustible material of the fuel and the oxygen of the air.

In commercial practice, the requirements for perfect combustion are a surplus of air, a thorough mixture of the fuel particles with the air and a high temperature.

The two principal products of combustion are carbon dioxide and carbon monoxide.

2 (a). What are the appliances generally used to feed boilers? Which is the more economical?

A. Reciprocating or centrifugal pumps and injectors are the principal means of feeding water to boilers. Of these the injector is the more economical and efficient. It has disadvantages, however, insofar as being unable to handle hot water, unable to maintain a continuous flow under extreme variation of load and under some conditions is uncertain of operation.

2 (b). What height in feet may pure water be balanced by a pressure of 14.7 lb.?

A. At a temperature of 62 deg. F., one foot of water exerts a pressure of 0.433 lb. per square inch. A pressure of 14.7 lb. will therefore counterbalance a column of water having a section of 1 sq. in. and a head of 14.7 divided by 0.433 or 33.9 ft.

2 (c). In feeding a boiler with an injector against its own pressure, from where does the power come? Could the same injector be employed to feed a second boiler carrying steam at a higher pressure?

A. It is due to the high velocity of the steam imparted to the water that this may be forced into the boiler from which the steam is taken.

The same injector can be employed to feed a second boiler carrying steam at a somewhat higher pressure.

2 (d). Why is it difficult to raise hot water on a long lift with an injector?

A. Due to the fact that as the pressure above the surface of the water is reduced, it will boil and steam will be formed, thus destroying the vacuum. As a consequence, the water will not rise in the suction line.

2 (e). What does pump duty mean?

A. Pump duty generally refers to the number of foot-pounds of work developed by a pump per each 1000 lb. of dry steam consumed or per 1,000,000 B.t.u. furnished by the boiler. Although the latter unit is more rational, it has not found favor among the manufacturers because it gives a slightly lower duty.

2 (f). What does the term slip mean as applied to a pump? With a pump in good working order, about what percentage of the capacity of the pump will the slip be?

A. For each stroke of a reciprocating pump, a volume of water is delivered somewhat less than the displacement of the plunger; and it is the product of 100 times the quotient obtained by dividing the difference between this volume of water and the piston displacement, that is called the per cent slip. An average value for piston and plunger pumps in first-class condition is 8 per cent when operating at rated capacity.

2 (g). How would you determine the size of feed pump required to supply a boiler of given size?

A. In determining the proper size of pump for a steam boiler, allowance must be made for a supply of water sufficient for the maximum capacity of the boiler when overdriven, with an additional allowance for feeding water beyond this maximum capacity when the water level in the boiler becomes low. The average run of horizontal tubular boilers will evaporate from 2 to 3 lb. of water per square foot of heating surface per hour, but may be driven up to 6 lb. if the grate surface is too large or the draft too great for economical operation.

Therefore, in order to allow for the meeting of a maximum demand, multiply the number of square feet of heating surface by 10, let us say. This will give us the demand in pounds per hour. As pumps are generally rated in gallons per minute, it will be necessary to divide the above demand by 8.33 and the quotient thus obtained by 60.

Referring to a manufacturer's catalog, we can at once determine the size of pump necessary to meet the maximum demand, whether the pump selected be of the centrifugal or simplex or duplex reciprocating type.

(To be continued)

Turbine Pressures

WHAT IS the pressure in the first stage of a Curtis turbine operating under full load? ENGINEER.

A. Assuming a Curtis turbine operating at a pressure of 150 lb. absolute with 150 deg. F. superheat, and a condenser pressure of 1.5 lb. absolute; the total heat drop is 316 B.t.u. per pound of steam. If the turbine has 3 stages, this drop would be almost evenly divided, and the first stage would have about 105 B.t.u. per pound. By reference to a steam temperature pressure diagram, we find a corresponding pressure of 43 lb. for the first stage. W. P.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

Is His Method Correct?

ON PAGE 559 of the July 1 issue, R. A. F. asks for criticisms of his method of paralleling two alternators.

I do not think that there is anything wrong in his method, but it is one not generally followed. He states that he uses this method with less trouble and considerably less voltage variation, which I understand to mean that he proceeded in the usual way, and paralleled his exciters and alternators without taking his regulator off.

My guess is that when following the usual method he has trouble from trying to parallel his exciters before synchronizing the two alternators, thereby getting into trouble on account of speed variations of his incoming machine. It is usually possible to make the running exciter carry the additional load imposed by the field of the incoming machine, until it has been synchronized, when its exciter can be paralleled with the other without causing any fluctuation in voltage.

His theory that the regulator performs any of the functions that an equalizer connection on a direct-current generator does in the division of the load between two machines, is unfounded. Division of load between two alternators can be regulated only by changes in governors of the driving units. Changing of excitation by means of field rheostats in alternator fields does not vary the load on the alternators, but serves to divide the wattless current of the system between the two.

Usually the field rheostats of the alternators are kept at a point that will keep the exciter voltage within some predetermined limits, generally from 90 to 125 v.

I would also state that most operators I have known hesitate to cut regulator off, excepting it be at times when load is very steady and even, then, with careful handling, there is apt to be more fluctuation of voltage than with regulator in service.

L. P. FESSENDEN.

THE DESCRIPTION of the ideas and object of R. A. F. seems rather vague, and his methods and objects are different from any the writer has ever encountered. I may not have grasped his idea as he intended to convey it, but offer the following suggestions. Though not so stated, I believe he refers to the Tirrill voltage regulator.

In the second paragraph, he describes the "cutting out" of the regulator to obtain hand regulation of the voltage. It is of no advantage, in the case of a Tirrill regulator, to open the relay reversing switches, as he does to cut out the regulator, unless it is with a special application to his plan.

Usually the regulator would not be "cut out" to parallel the alternators. The exciters would be paralleled on the exciter bus and divide the direct-current load after the single blade switch for the incoming exciter had been put in on the regulator. The alternators would then be put in parallel.

He brings the alternators to synchronism the same as is usually done, and then closes the regulator switches, not having yet thrown the alternators together. He does not yet "cut in" the field resistance on the exciters, and outside of that fact he is right where he was in the first place, with nothing yet gained by having cut out the regulator. He then puts in the main switch of the incoming alternator and regulates the rheostats of the exciters, and the regulator is working again. This operation, as far as results go in regard to load and voltage control would have been just as well and easier done if the regulator had not been touched.

His idea is that the regulator acts as an equalizer, as in direct-current work. It is not clear what he means or just what is supposed to be equalized.

Now the exciters are not in parallel on any regulator circuit (they are in parallel only on the exciter bus), and the two circuits from the regulator relay contacts to the exciter field rheostats are independent of each other. The regulator does not control the division of load between the exciters, or alternators. The difference of load, or the division of load, is controlled by the characteristics of the exciters, and the effect of the time element in regard to the amount of rise of voltage in each when the regulator relay contacts are closed. If the exciter rheostats are set at the proper mark, and one exciter takes an undue share of the load, an auxiliary rheostat is used to hold back on this exciter. Therefore the regulator in no way affects the load division, and the exciters are equalized in the regular manner. Neither do the alternators, field rheostats, or the exciters affect the load division. The only reason for adjusting the alternator field rheostats after the alternators are in parallel is to eliminate the alternating-current cross currents. When the machines are at the proper speed and voltage, close the switch of the incoming alternator and there will be no load or voltage disturbance if the regulator is and has been in continuous service. Adjust the governor for load division and the alternator field rheostats for voltage balance to eliminate cross current. The exciters will have automatically taken care of the increased direct-current load.

I disagree with R. A. F. in regard to cold alternators taking the big share of the load as in the same condition as with direct-current machines. The temperature of the alternator is not a factor of its load capacity, except as to safety, and not as to liability or inclination to work. The voltage balance of the two machines does not affect the division of load, except as regards the cross current, which is not load proper. The governor of the driving unit is in control of the output, and, for illustration, it can be "cut" so low that the turbine or engine will be

driven by the generator acting as a motor and taking current from the other machine.

There is no principle calling for an "equalizer" for alternating current, and neither does the regulator equalize the exciters. In answer to his question as to the harm and danger of damage, I believe the operation to be harmless and not liable to any damage, and also useless, as nothing has been accomplished. The method seems to indicate confusion of the principles of alternating and direct currents. I would advise following the regular procedure, which is:

1. Leave the regulator in service.
2. Parallel the exciters on the exciter bus.
3. Put the exciter field switch of the second exciter in on regulator.
4. Bring alternators to speed, set voltage right, then synchronize.
5. Increase load on alternator just brought in.
6. Eliminate any cross current between the alternating current machines.

As the exciters will be under the control of the regulator continuously, and the alternating-current line voltage steady, the incoming machine voltage all right, and the machines in perfect synchronism, there will be no voltage change on the alternating-current line, nor change of load on the alternator already in service. After synchronizing, the machine that was in service will still carry the same load, and there will be no load on the second machine until the load increases, or more steam is given the driving unit either by means of the throttle or the governor. WM. C. THORN.

Can You Tell Him?

IN REPLY to the questions submitted by J. W. Dickson on page 559 of the July 1 issue, I would state that with equal cutoff in the cylinder of a Corliss engine, there will be a slight difference in the terminal pressure, due to the presence of the piston rod. There should, however, be no difference in the release lines if the exhaust valves are set correctly. Changing the point of cutoff will not affect the compression, but having an unequal cutoff will result in the engine not operating smoothly,

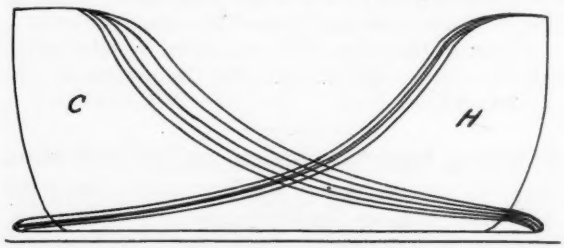


FIG. 1. TYPICAL CARD FROM CORLISS ENGINE SHOWING VARIATION OF LOAD

owing to the fact that the piston will receive a greater impulse on one stroke than on the other.

The accompanying cards indicate the result of varying the load on Corliss and throttling governor engines.

I would equalize the work done in the two ends of the cylinder and let the cutoff take care of itself.

THE CHIEF.

WITH EQUAL CUTOFF in a Corliss engine, there will be little, if any, difference in terminal pressures, and also in the release lines. Any difference that may exist is due to the volume occupied by the piston rod, which lessens the volume of steam at that end of the cylinder, while the exhaust valve opening is presumed to be the same for both ends. This may perhaps make a difference as questioned by the correspondent.

Changing the point of cutoff in a Corliss engine does not seem to affect the compression; for, in diagrams which show load fluctuations by tracing several expansion lines, but one compression line is traced on each diagram.

Varying the cutoff may offset the smooth running of the engine, according to prevailing conditions. (I would refer the correspondent to Harry D. Everett's letter in the July 1 issue, page 561, which indirectly bears on this subject.)

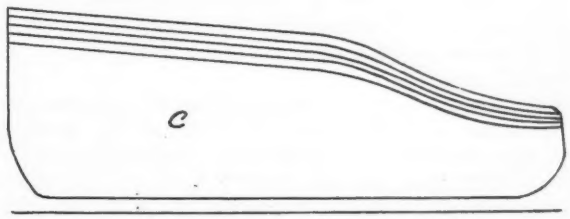


FIG. 2. TYPICAL CARD FROM THROTTLING GOVERNOR ENGINE SHOWING VARIATION OF LOAD

In Fig. 3 is shown a diagram from a Corliss engine with varying load condition. The initial pressure remains the same, but the point of cutoff changes with change in load.

In Fig. 4 is shown a diagram from an ordinary, simple slide-valve engine, with a throttling governor. Here the point of cutoff remains constant and load change is taken care of by change in the initial pressure. The two diagrams are representative of the two types of engine valve gears, under changing load conditions.

Answering Mr. Dickson's final question, I would say that, practically speaking, equal cutoff is practiced more than equal work between the two ends of an engine cylinder, because it is easier to do, as a general rule. Strictly speaking, it would be better to equalize the work than to equalize the cutoff, but the difference would be very little. It is one of the fine points that may or may not be taken up, according to the whim of the person interested. CHAS. J. MASON.

IF THE POINTS of cutoff on a Corliss engine are equal, there should be no difference in terminal pressure; but, should the steam valve on one end be leaking enough to admit much steam to the cylinder after the valve has been tripped and closed, the terminal pressure would be some higher at release on the diagram of that end of the cylinder than it is on the one of the opposite end. It is usually unequal cutoff that causes the greatest difference in terminal pressure. With equal cutoff, there may be a fractional difference in the mean effective pressure of the diagrams taken from each end of the cylinder, but it is very slight. This would be due to piston rod displacement and may be partially made up by allowing a small amount more of lead on the crank end steam valve, than is allowed on the head-end steam valve. The point of release remains the same for all loads, as it is controlled by the exhaust valve.

2. Changing the point of cutoff in a Corliss engine does not change the compression, as the exhaust valve is set at a point to close for whatever compression may be desired, and is not affected by the governor changing the point of cutoff. Though a leaking steam valve may admit more steam to the cylinder after the exhaust valve has closed, the card may show unequal compression, being higher than on the other end of the cylinder.

3. Varying the point of cutoff should not in any way interfere with the smooth operation of the engine. In most Corliss engines, the governor varies the point of cutoff according to the load. But in compound engines often the point of cutoff on the low-pressure cylinder can be changed or varied to keep up the receiver pressure and keep the load equally divided between both cylinders. This is necessary when running a compound Corliss engine condensing on light load to prevent the low-pressure cylinder acting as a pump and drawing back the water from a jet condenser and wrecking the engine.

4. Load variations as indicated by an indicator card are earlier or later points of cutoff, as the governor changes this point and if the pencil is held against the card while these changes occur, there will be drawn numerous expansion lines corresponding with the different points of cutoff.

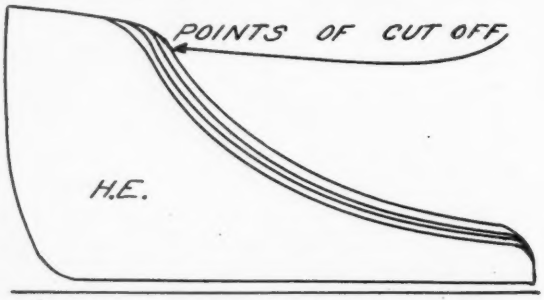


FIG. 3. DIAGRAM SHOWING VARIATION OF LOAD WITH A CORLISS ENGINE

The simplest slide valve with a throttling governor regulates the speed by shutting off the steam or throttling it down so only enough steam enters the cylinder to maintain the required speed. While the port is opened full width and closed at about ¾ of the stroke, the steam being wire drawn through the throttling governor valve, the card would show but about ½ of full boiler pressure. A throttling governor engine is not desirable for large power plants. With the Corliss valve the steam from the boiler is admitted to the cylinder at nearly full boiler pressure which is exerted on the piston at beginning of each stroke up to point of cutoff. Measuring the height of the diagram and knowing the scale of the spring of the indicator, the spring indicates the pressure for each inch of height of the diagram.

5. The last two questions have but the one answer. To equalize the cutoff between the two ends of the cylinder, you are doing nothing more or less than equalizing the load. R. A. CULTRA.

[Two cards showing the effects in the indicator diagrams of varying the load on Corliss and throttle valve engines were submitted by Mr. Cultra. These cards are, however, not published for the reason that the performances disclosed by them are not greatly unlike those shown in the cards of Mr. Mason.—Editor.]

Combustion Problem

IN THE July 15 issue, if R. A. F. had given a few more details concerning the question of increased flue temperature of his boiler after having replaced coal with tar oil as a fuel, a more definite answer could be given. For instance, the point at which the gas sample was taken should have been given, for if it was taken at the same point as that at which the temperature was observed and with tight baffles, as he mentions, it is indeed a remarkable case, and I would suggest that he check the accuracy of his thermometer and also that of the flue gas analyzer, as so high a flue gas temperature would indicate a much lower CO_2 reading, or a considerable increase in the boiler capacity. If after checking, the results are found to be the same, I believe the trouble to be due largely to dirty (i.e., sooty) heating surface.

Some engineers are of the opinion that oil of any kind used as a fuel does not produce soot. This is indeed a great mistake, as many have had good cause to admit, for with only a minimum amount of smoke the heating surfaces will become smudged over very quickly, and even in cases where no smoke is observed, some soot will collect, especially in the cooler portions of the passes. There is also considerable ash, sulphur, etc., contained in some crude oils which invariably forms in a hard grayish scale upon the heating surface. This formation

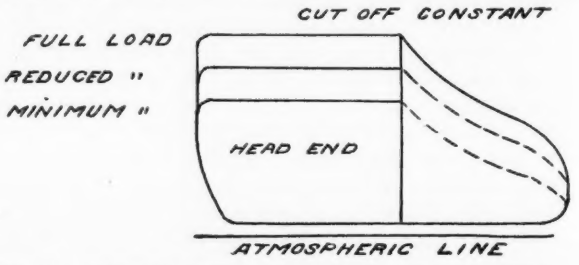


FIG. 4. DIAGRAM SHOWING VARIATION OF LOAD WITH A SIMPLE SLIDE-VALVE ENGINE

is most noticeable on the lower tubes in the first pass, i.e., the surface nearest the flame, and it is well known any foreign matter upon the heating surface acts as an insulator and results in a great temperature difference between the flue gas and that of the water or steam.

I believe that if R. A. F. will give his boiler a thorough dusting, he will find that the flue gas temperature will drop considerably. A. C. MCHUGH.

Changing from Noncondensing to Condensing

IN THE Aug. 1 issue, I was interested in the article, "Operating Engines Condensing and Noncondensing." I understand that some engineers think it unnecessary to give a condensing engine more compression than a noncondensing, but I differ from them. A little over 2 yr. ago I took charge of an electric light and power plant consisting of one Corliss and one high-speed engine. The water was very hard and scaled the boilers, so we decided to install a surface condenser and run the engine condensing, which we did. We arranged so we could exhaust to atmosphere or into the condenser. When we turned the exhaust from the Corliss engine into the condenser it developed a pound in the cylinder and main bearings, so I went over the engine, set out the junk ring, tightened up the bearings, but to no

effect, so I put the indicator on and took a card. I took the valve bonnets off and examining the valves I saw the main steam valves had about 1/32 in. lead, so I took it up with the builders of the engine, told them I had given the steam valves 1/32 in. lead, sent them the card of the engine and told them how the engine performed. They wrote that 1/32 in. lead was about right, but to give the engine, when running condensing, much more compression, which I did, increasing it until the engine ran quiet and smooth and very economical. This incident proves to me that an engine requires a great deal more compression condensing than non-condensing.

A. REDBURN.

What Is Your Opinion?

THE CARD submitted by G. W. M., page 597 of the July 15 issue, shows a very poor valve design. G. W. M. does not give the scale of spring used or the boiler pressure carried when the diagrams were taken, and for that reason, it will be difficult for anyone to give a thorough analysis in this case.

In criticizing the card taken with the engine loaded, I would say that the head end diagram shows late admission. The valve closes for expansion after 4/5 of the stroke has been made by the piston. The exhaust is restricted in leaving the cylinder. There is practically no compression. The crank end admission is a little late. The diagrams show the steam being admitted to the cylinder until the piston has completed the stroke, and also indicate that this volume of steam is exhausted before the piston begins to move to make the reverse stroke. The valve does not close for compression.

If the engine is of the ordinary D slide valve type with inside and outside lap, I cannot conceive how it is possible for the steam to be admitted up to the point of exhaust as shown on head end diagram.

I would suggest that the travel of the valve be equalized and the eccentric advanced for an earlier opening and closing of the valve, a change which may cause excessive lead before the proper cutoff occurs. If so, I would add ¼ in. to the outside lap of the valve and advance the eccentric for the desired lead, cutoff and compression. This additional outside lap will necessitate a little higher initial steam pressure in the engine cylinder, but there will be an appreciable amount of fuel saved in the boiler room.

J. W. DICKSON.

Eliminating Corrosion

REFERRING TO THE issue of July 1, 1917, I note a request as to how corrosion may be eliminated. The Research Laboratory of the National Tube Co. has been investigating this matter for a good many years, particularly with reference to corrosion in hot water supply lines. The cause of the corrosion must be appreciated before any attempt is made toward a solution of this problem. It is now well established that dissolved oxygen and carbonic acid is responsible for practically all corrosion in boilers and hot water lines. The removal of these gases from the water may be accomplished in at least two ways, and has proved a solution of the problem in many cases in service. Reference may be made to National Tube Co. Bulletin No. 3D, pages 7 to 18, for some details of what has been done in our laboratories on this subject, also to an article on page 449, May 15, 1916, issue of Practical Engineer.

I might state from practical experience at one of our large plants, that we use the same water in our stationary boilers as is used in switching engines around the yards. We have never had any trouble with corrosion of tubes in stationary boilers, whereas we are continually having trouble with pitting of locomotive tubes of the same steel, the reason being that we have large open feed-water heaters run at a temperature of about 170 deg. F. in connection with the stationary boilers, whereas the feed water is taken into the tenders of the switching engines cold and at this temperature the water naturally is saturated with oxygen and carries some carbonic acid. Probably a solution of the trouble mentioned lies along this line. If the receiving tank mentioned is open to the air and kept at a temperature over 170 deg. F., the pitting of the tubes will probably be eliminated.

F. N. SPELLER.

IN REPLY to the communication of W. S., page 559 of the July 1 issue, I would state that this action may be due to the use of pure water or electrolysis, either or both.

It is a known fact that where water is used over and over in boilers, pitting will occur, which, however, may be stopped by adding raw water for make-up.

If the trouble is due to electrolysis, suspend zinc plates in the boiler, being certain of having good electrical contact between the plate and the shell and that the zinc plate is nearly covered with water.

FRANK WELLS.

Securing a Raise

I NOTICE a request from "The Chief" for information on this subject. How important it is at this time of high prices and forced economy, both national and individual!

Let us assume that the applicant considers himself worthy of a greater salary. Let him find out whether general market conditions warrant an advance. Are conditions of life more severe? Can he get more money elsewhere for similar service? Is he keeping posted, and is he improving? Has his responsibility increased? Can he do any other kind of work that pays better?

How independent can you afford to be? Are you taking care of every dollar of your own and are you trying to save as much as you can for your employer?

Imagine yourself in your employer's position—step to one side, take a look at yourself and say you are worthy of more. Ask for it in the right way and at the right time and you will probably get it if the job is worth having.

H. L. SHERMAN.

THERE IS a scarcity of toluol for making high explosives, and the chemical committee of the Council of National Defense is taking steps to have the gas supply of large cities stripped of this by-product. This will change the nature of gas to some extent, but it will be treated in other ways to maintain a satisfactory illuminating standard. Gas consumers in cities will have to become accustomed to a different kind of gas. Toluol is used in making trinitrotoluol, one of the most valuable high explosives.

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The Plant in Order

Although summer is still officially with us, the days are shortening and ere long chilly nights and cool mornings will bring forth calls for heat, and while many engineers have, during the past few months, taken advantage of their opportunities and have placed their heating plants in readiness for the coming winter, others either through neglect or otherwise have failed to do so. As a consequence, much inconvenience and discomfort among those dependent upon this service may be occasioned.

What have you done? Have you busied yourself making such repairs and improvements as will insure continuous and economical operation of the system for the next 10 months, or have you let it go because your time has been taken up with other duties? If so, a few short weeks still remain in which you can and should give your time and attention to this all-important matter.

Indications point to no material reduction in the cost of fuel and this, together with our present national crisis, places upon engineers more than ever the duty not only of seeing that every pound of coal burned is made to yield its greatest number of available heat units, but also to see that each of these heat units be employed in the most useful manner. It is, therefore, imperative that in the interests of yourself, your employer and your country, you recognize the necessity for economy and that you put forth every effort tending to conserve our fuel supply.

Grates and pits were, of course, cleaned of ashes and refuse when the heating plant was shut down; but are you sure that those accumulations of soot on the exposed shell surfaces and in the flues, and the scale and sediment inside the shells were removed? If you are not certain that your boiler is clean and in condition to fire up at any time that you may be called upon to do so, climb inside and find out. At the same time, note the condition of the setting walls, and if you discover any defective brick work, shell plate bags, loose stays or braces, or seams which may require calking, see that these are attended to at once and placed in order.

Much heat, otherwise wasted, may be usefully employed by providing the boiler settings, the main steam headers, the distribution lines and the receiving tanks with a covering of efficient heat insulating material. Where this has already been done, but where such insulation is in questionable condition, repair it or replace with new.

On the distribution lines many sources of leakage and waste may exist. Examine all the valves and where their seats or discs are in bad condition, regrind them or replace with new ones; inspect and adjust all air vents and traps and see that the radiators drain properly. And where pressure reducing valves and back pressure valves are employed, test these to see that they are in operative condition and do not stick. Attention should also be given the vacuum pumps to see that they may be depended upon to perform their duties.

With the equipment in order, do not allow your vigilance to relax, for of equal, if not of greater importance in the economical operation of the plant, is the attention given after the steam has been turned on.

The cheapest coal is not always the most economical in the end, and it is frequently only by trial and experiment that the grade best suited to meet local requirements may be determined. After this has been determined, due attention must be given, however, to the method of firing employed, and from his own experience the really proficient engineer knows that the highest degree of efficiency may be realized only by carrying a thin fuel bed and by firing lightly and often rather than by filling his furnace once every few hours and forgetting about it the rest of the time. Such procedure is not only wasteful, but dangerous.

Considerable energy loss can also be traced to inefficiently-operated ventilating equipments. These are generally designed and built to a size based upon the approximate number of persons which may at any time occupy the space served by them and unless care be taken that the fans be kept running only when the needs demand so doing or that the speeds of the fans are varied according to actual requirements, more air will be handled and consequently more energy consumed than is necessary. Variable speed motors might be provided for this purpose and while it would of course be impossible either automatically or manually to change the speeds of the fans in direct proportion to the volumes of air needed, a little care and frequent attention on the part of those in charge will prevent much waste.

Have You Read This Issue Carefully?

If so, can you tell the approximate size of steam generating equipment necessary for a refrigeration plant having a daily capacity of 600 tons?

What temperature would you advise maintaining for the storage of eggs? for meat and butter?

In what manner do Stirling boilers built in Europe differ from those of American make?

A priming boiler will scale up a superheater, but the scale deposited by a particular water in the boiler will be different from that deposited from the same water in the superheater. Why is this so?

How do you satisfy yourself that apparently defective lamps and fuses are no longer serviceable?

Make a rough sketch of the arrangement of the new Westinghouse-Leblanc refrigerating machine.

Assume you are in charge of a boiler plant of 5500 hp. and that the boss has requested you to submit an estimate of the approximate cost of installing an underfeed stoker equipment. Could you give him the information?

On page 705 is a description of what is believed to be the smallest internal combustion engine of the Diesel type ever built. What is the object of the two-stage air compressor there referred to?

Can crude oil be used more economically than coal at present prices?

What are causes of pounds in crosshead and crankpin bearings?

How would you go about making piston rings if you had only a drill press to work with?

What determines the size of a boiler feed pump?

What effect do voltage regulators on a.c. generating systems have on the load distribution for machines working in parallel?

Are you really *using* Power Plant Engineering?

Food Saving

WITH generous harvests promised and under way, it is difficult to realize that utmost rigid economy is necessary to save ourselves and the allied nations that look to us for help from a serious shortage during the coming winter. We know that costs are high, but the markets are still well supplied, and the movement to sell cattle, poultry and hogs rather than feed them does not come to our attention.

Those whose business it is to watch such things warn us, however, that the grains needed by the European countries and our own forces abroad will make a heavy demand on our resources, spite of our large crops, and the young stock and milch cows are being sacrificed to such an extent that meat and milk will be difficult to obtain before the next winter.

It becomes a matter of serious business and patriotic duty, therefore, to assist in every way possible to forestall such shortage, and it is a matter for individual and family attention that all should give heed to the food pledge asked by Mr. Hoover, the Food Administrator. His thought is not to limit the plain food of growing children or to curtail the reasonable and necessary food supply of anyone, but to avoid luxury and waste, to substitute other grains for wheat to a considerable degree, to use fruits, fish and vegetables in place of meat, to see that no milk is wasted, and to preserve surplus fruits and vegetables by drying and canning so that they may be available later.

Details of the co-operation asked by the United States Food Administration are as follows:

One wheatless meal a day, using corn, oatmeal, rye or barley. Use non-wheat breakfast foods. Cut bread only as wanted and use stale bread for toast and cooking. Cut down on cake and pastry. Eat beef, mutton or pork not more than once a day, and utilize all left overs for made dishes. Substitute more vegetables and fish for meat.

Use buttermilk and sour milk for cooking and to make cottage cheese. Cut down on the use of cream. The children must have milk, but grown-ups do not need it.

Use butter on table, but for cooking other fats are as good. Waste fats are good for soap.

Sugar is scarce. Use it for putting up fruits and jams; that will save butter. Cut down on candy and sweet drinks; that will save your stomach. We are using three times as much sugar a person as our allies.

Coal is scarce and transportation difficult. Use the fuel from as near home as possible and keep as few fires as possible. Burn wood where possible.

Use the perishable foods, fruits and vegetables grown in your own vicinity. It will save food and transportation. Store and dry the surplus. Then you can eat plentifully next February. And doubling the vegetables in your diet to replace meat will improve the health of the whole family.

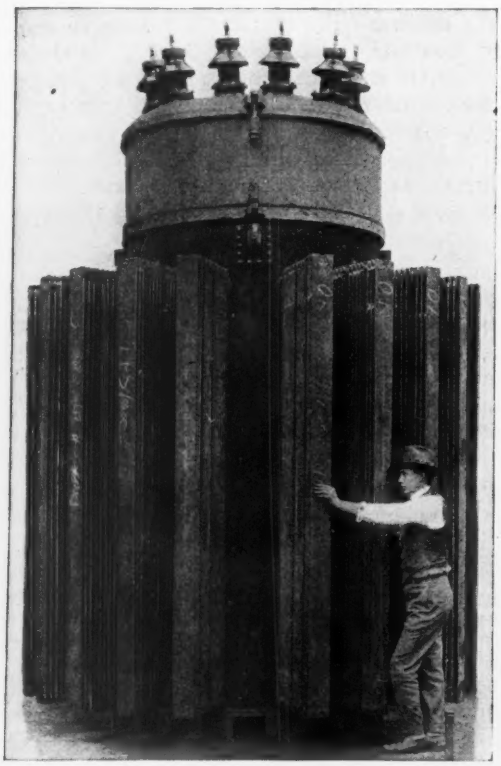
All Power Plant Engineering readers are good engineers, and good engineers are always good citizens, so it is only necessary to call attention to the need to help the country and one's fellows by joining in the effort for food and fuel economy.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

A Present-Day Giant

WHILE we may not have the human giants of old with us, their places are admirably filled by the gigantic mechanical apparatus that modern genius has evolved, as, for instance, the device shown in the accompanying illustration. This shows the largest self-control induction feeder voltage regulator that has ever been built. The regulator, which is of the oil-insulated, self-cooling type, was made by the Westinghouse Electric & Mfg. Co., and is rated at 600 kv.a., 3-phase, 60 cycles, 13,200 v., with 10 and 20 per cent



LARGE INDUCTION FEEDER VOLTAGE REGULATOR BUILT BY WESTINGHOUSE ELECTRIC AND MANUFACTURING CO.

regulation at 262 and 131 amp. It is designed for operation outdoors with full automatic control self-contained.

This regulator was built for the Southern Power Co. and is to be connected to the low-voltage side of a 6000 kv.a. bank of 44,000 to 13,200-v. transformers on the power company's line at Spray, N. C. By the use of this regulator, the power from the line will be delivered to the Thread Mill Co. mills owned by the Marshall Field interests, with the voltage maintained continuously at normal value.

Curtis Steam Turbines for Fans, Blowers and Pumps

THE GENERAL ELECTRIC CO. has developed a Curtis steam turbine in a wide variety of capacities to drive fans, blowers and pumps for boiler feeding and circulating systems.

It is called the Type L and is of the impulse type. The number of stages and rows of buckets vary with the capacity. The principles used and mechanical practice evident in the construction are the result of the vast

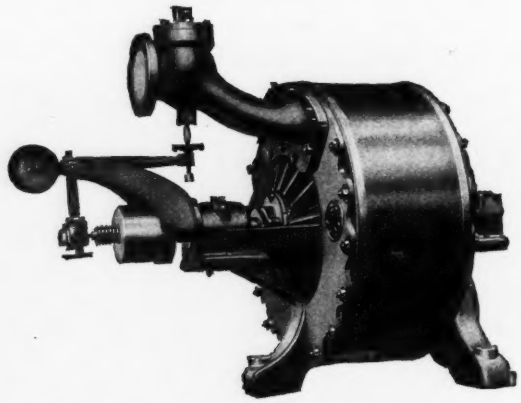


FIG. 1. TYPE L, CURTIS STEAM TURBINE

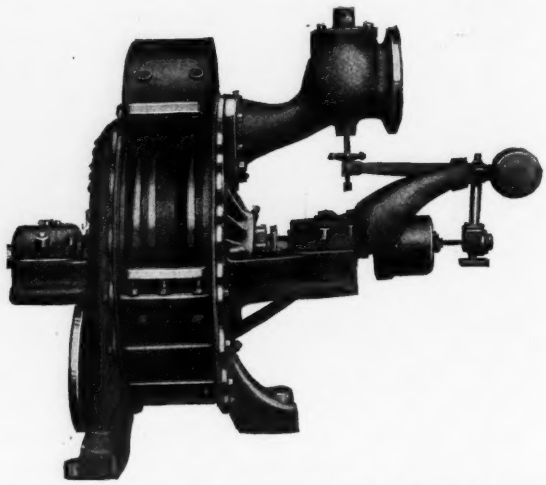


FIG. 2. TYPE L, CURTIS STEAM TURBINE SHOWING SPLIT CASING

experience of the manufacturers in producing turbines for practically every class of service.

A split wheel casing is used to permit ready inspection of the buckets, which are of bronze securely dovetailed into the rim of the wheel. The exhaust steam is free from oil and is well suited for heating feed water.

Speed regulation is close and reliable and the speed may be changed by hand-wheel adjustment while the turbine is in operation. A constant running speed is maintained by a simple and powerful speed governor mounted directly on the shaft and controlling a double balanced piston-valve type throttle.

The main shaft carrying the turbine and governor runs on babbited bearings with renewable linings, and is fitted with readily accessible packing glands.

Three feet support the rigid frame of the turbine to insure the bearings always being in line. The wheel casing is neatly lagged with planished iron.

Catalog Notes

OUTDOOR METERING OUTFITS, described in Bulletin 46,251-B, which has just been issued by the General Electric Co., are admirably adapted for use in outdoor substations for measuring the amount of power supplied to the various feeders. These outfits are compact in design, are built especially for outdoor metering service, and are offered as thoroughly reliable and accurate units. They may be furnished for either single or polyphase circuits to operate any usual meter combination and consist essentially of the required meters with the necessary instrument transformer elements. The transformer elements are modifications of standard switchboard transformers, thus maintaining the company's standard of operation. All parts are mounted in suitable weatherproof housings with two compartments, one for the transformers and one for the meters. The standard outfits are for three-wire three-phase circuits and are equipped with a watthour meter only. Low installation and maintenance cost, accessibility for inspecting and testing and safety of construction are special features mentioned in the bulletin.

THE NATIONAL BOARD of Fire Underwriters, 76 William St., New York, has prepared for the Council of National Defense and is mailing to leading manufacturers a booklet of directions for the prevention of fire, under the title of Safeguarding Industry, together with a showcard of fire prevention rules for employes. Its particular purpose is the prevention of fires in industrial plants which are working under the abnormal conditions of war time emergency.

Manufacturers who fail to receive copies will be supplied on request.

SPRAGUE ELECTRIC WORKS Bulletin No. 48,923 on worm-geared electric hoists, one ton to six tons, was lately received.

THE LARGEST GRAPHIC METER for the Largest Plant in the World is the title of a circular from the Esterline Co., of Indianapolis. Halftone views of the instrument are given, also the interior of the switchboard room of the Mississippi River Power Co., Keokuk, Iowa. The meter has a capacity of 250,000 kw., and draws the output curve of the entire station on a single chart.

CROCKER-WHEELER CO., Ampere, N. J., is distributing Bulletin No. 181, superseding No. 156, on motor-generator sets for all purposes.

BULLETIN NO. 14 of G. E. Witt Co., San Francisco, Cal., enumerates advantages of the company's Simplex Frictionless pressure reducing valves.

NEW CIRCULARS from Golden-Anderson Valve Specialty Co., of Pittsburgh, illustrate and describe Golden-Anderson automatic cushioned valves for steam and water service.

S K F BALL BEARING CO., of Hartford, Conn., has just issued an illustrated folder containing statements from a number of manufacturers giving their opinions concerning the use of S K F ball bearings on machines of their manufacture.

FROM SUPERNO CO., INC., 52 Broadway, New York, we have received a 32-page catalog of Superno patented steel superheaters, which shows by illustration their adaptation to a large number of different boilers.

AIR HANDLING and Power Plant Machinery is the title of L. J. Wing Mfg. Co.'s Turbine Blower Bulletin 37, superseding Bulletin 27.

Bulletin No. 11, the "Wydawake" Damper Regulator, is also one of a list of bulletins any of which will be sent on request to those interested who address the company at 352 West 13th St., New York.

GENERAL ELECTRIC CO. circulars were recently received as follows: No. 63,950, relating to the Tungar rectifier, a new battery charger for use with alternating current; No. 62,551a, Small Battery Outfits, for charging ignition and lighting batteries; No. 62,556, Individual Vehicle Taper Charging Set with automatic panel for use in connection with vehicle equipped with ampere-hour meter.

SPRACO Pneumatic Painting Equipment is the subject of a new bulletin succeeding a former one describing the Spraco Paint Gun, a device which has since undergone considerable development and become a much improved and finished product.

Spray Engineering Co., Boston, Mass., will be pleased to send copies of this bulletin to those interested in the subject.

THE BUREAU OF MINES, Washington, D. C., has just issued a chart showing by illustrations and giving full directions for the Schaefer method of artificial respiration to be used in cases of drowning, electric shock, or gas strangulation. Copies of the chart will be sent, free of charge, to all persons requesting it, as long as the edition lasts. It is suitable for posting about mines and engine rooms.

LINK-BELT BOOK NO. 326 discusses roller chain equipment for tractors and trucks, describing the new curled roller, offset link and other features.

Book No. 361, Some Facts About Roller Chain Devices, relates the experience of a user of Link-Belt roller chain drives.

Copies of these booklets will gladly be sent to anyone interested who addresses Link-Belt Co., 39th St. and Stewart Ave., Chicago.

Trade Notes

SARCO CO., INC., of New York, has received orders for temperature regulators for each of the 16 cantonment camps, as well as for the Selfridge Aviation Field, near Mount Clemens, Mich., and for the League Island Navy Yard at Philadelphia, Pa.

THE BORDEN CO., Warren, O., recently shipped to one of its customers in the oil fields at Tulsa, Okla., a full car-load of Beaver Easy Working die stocks and square end pipe cutters, a single car-load shipment of Beaver die stocks representing a greater amount of money than two solid train-loads of iron ore—or more than 100 car-loads. In addition, the company is shipping more than 100 Beaver tools on an average, every day, for use on U. S. Government work, including the new cantonments, aviation fields, National Guard camps and naval bases. In fact, Beaver tools have been furnished in quantities up to 300 to 14 out of the 16 army training cantonments now being built.

MANUFACTURING will begin immediately in the new plant of the Chas. A. Schieren Co., of New York City, built as an addition to its tannery at Bristol, Tenn. The buildings are entirely completed and the equipment of machinery is being installed for the manufacture of the highest grade machine belts, the greater portion of which will be shipped to Southern plants. A working force sufficient to produce 24,000 lineal feet of belting daily will be employed at the start and gradually added to, as skilled help can be secured, until the full capacity of the plant, 50,000 ft. daily, is reached. Among Schieren brands of belting, known throughout the world, are Duxbak (Waterproof), Bull's Head, Royal Extra and CasCo.

TWO RECENT ORDERS for steel mill equipment reflect the urgent need of additional productive capacity. The Atlas Crucible Steel Co. has ordered for its Dunkirk, N. Y., plant a standard rolling mill drive consisting of a 450-hp. wound-rotor induction motor, a rotary converter, and a 130-hp. direct-current motor. This apparatus is so interconnected that at heavy loads the rotor currents supply power through the rotary converter for the d.c. motor which in turn helps drive the mill. The manufacturer of this outfit, the Westinghouse Electric & Mfg. Co., of East Pittsburgh, Pa., have also received from the Brier Hill Steel Co., of Niles, Ohio, an order for a 132-in. plate mill equipment consisting of a 5000-hp. induction motor with primary control panel and step regulator; a 24-in. reversing roughing mill with a 7600-hp. d.c. motor and a 2250-kw. 1500-hp. motor-generator set with 60,000-lb. flywheel; and an 84-in. plate mill equipment with 2500-hp. induction motor, primary control panel and slip regulator. Additional electrical equipment ordered for this plant includes two 750-kw. synchronous motor-generator sets and four 3500-kv.a. radiator-type transformers.

POWER PLANT ENGINEERING

Trade-mark, Reg. U. S. Pat. Off.

PUBLISHED THE FIRST AND FIFTEENTH OF EACH MONTH

SEMI-MONTHLY

Subscription price in advance in the United States, Mexico or united possessions, $1.00 a year.

In Canada, subscription price, $1.75 a year.

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Address all letters and make all checks and money orders payable to Technical Publishing Co., 537 S. Dearborn St., Chicago, Ill.

Any advertiser is invited to examine our paid subscription lists and Post Office mailing receipts at any time.

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Full page, one year, each insertion, $66.00.

Half page, one year, each insertion, $38.50.

Quarter page, one year, each insertion, $22.00.

Eighth page, one year, each insertion, $13.25.

Front cover, $175.00 per issue.

Other specified positions, regular rate plus 10 to 50 per cent.

Stippled plates used, but no heavy, black and white plates.

Classified Rates

Per line, 30 cents each insertion.

Advertisements in this section are inserted under regular headings.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 22,000.

Technical Publishing Co.

537 S. Dearborn Street

Chicago

Position Wanted

POSITION WANTED—By engineer; have Ohio engineers' and boiler inspectors' licenses. Experienced with absorption method of manufacturing gasoline. Good references. Address Box 481, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 9-1-1

POSITION WANTED—By a practical engineer with over 20 years' experience. Have I. C. S. Diploma. Can furnish best of references. Prefer Illinois or Missouri. Address J. M. B. Shanks, Dixon, Mo. 9-1-1

POSITION WANTED—Chief Engineer or Master Mechanic of Light & Power Co., or Factory, 12 years' experience. Age 30. Married. Present salary $1,500. Good references. East and middle west preferred. Address Kurt Illig, P. O. Box 77, Tuxedo, N. Y.

POSITION WANTED—As engineer in small steam plant not over 125 H. P., by young man. Steady and sober habits. More than 5 years' experience as engineer in grain elevator. Good mechanic. Address Box 123, Dixon, Ia. 8-1-3

POSITION WANTED—By steamfitter with 17 years' experience at the trade. Can furnish references as to habits and ability to handle men. I am 33 years old. Married. Address J. H. D., 669 Wunderlick St., Barberton, O. 9-1-1

POSITION WANTED—By thoroughly competent man with 11 years' experience as engineer and assistant superintendent in sugar factories in Cuba, Mexico and Louisiana. Good steamfitter and machine repairman. Have had charge of 10 steam boilers and 6 ammonia compressors as day and night engineer. Can speak English, Spanish and some German. Single. 26 years old. Can furnish good references. Address Box 480, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 9-1-1

POSITION WANTED—By young man, 23 years old, as fireman or oiler in ice or electric light plant in City of St. Louis. Have had one year's experience in firing and some experience in steam engineering. Address Leonard Ochs, 1536 Papin St., St. Louis, Mo. 9-1-1

POSITION WANTED—Young man wishes a position as oiler or assistant to the engineer in a plant in New York City. One year practical experience. Address A. Benora, 156 Willow St., Yonkers, N. Y. 9-1-1

POSITION WANTED—As chief engineer in central station of 2,000 k.w. or more. Have had practical experience with high and low speed engines and turbines, also A. C. and D. C. generators. Address Box 486, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill.

POSITION WANTED—By practical steam fitter, accustomed to work on high and low pressure plants, including pumps, boilers, engines and steel mill plants; 19 years' experience; capable of handling men and overseeing repairs and construction work; 35 years' old; married; steady and reliable. Can and will fill responsible position. Address Box 487, Power Plant Engineering, 537 S. Dearborn St., Chicago, Illinois. 9-1-1

POSITION WANTED—By young man as assistant engineer or assistant switchboard operator in plant in or near Newark, N. J., where there is a chance for advancement. Three years' practical experience. Address Wm. Wykes, 358 So. 7th St., Newark, N. J. 9-1-1

Help Wanted

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Cal.; Washington, D. C. This is an excellent chance for a hustler, who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. tf.

WANTED STEAM AND PRODUCER GAS ENGINEER—If any of your family need a change of climate to a higher altitude, we have an excellent opportunity for a first-class operating engineer in a two thousand kilowatt producer gas and steam turbine power plant in a growing community. Give references and salary expected. Roswell Gas & Electric Co., Roswell, New Mexico. 8-15-2

WANTED—Central Station Engineer, moderate size plant in middle west. State age, experience and salary expected. Address Box 484, Power Plant Engineering, 537 So. Dearborn St., Chicago, Ill. 8-15-2

WANTED—An engineer for electric light and power plant, station of 3,000 k.w. capacity, located in Pennsylvania. Address Box 488, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 9-1-2

Wanted

WANTED—Agents on commission to sell our shaking grates. We will install grates on trial or put it to test at our expense with any grate made. Address Armstrong Mfg. Co., Springfield, Ohio. tf.

WANTED—Agents handling engine and boiler room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Box 381, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. tf.

WANTED—Marine boilers. We will pay cash awards for information that leads to a purchase by us of marine boilers of from 75 H. P. to 250 H. P. The Pittsburg Boiler & Machine Co., Pittsburg, Kansas. tf.

For Sale

FOR SALE—125 volt generators; 20 k.w. G. E. with Ideal engine, $500; 2½ k.w. Marine unit, $300; 100 k.w. Wghse. generator, $700; 60 k.w. G. E., $400; 40 k.w. G. E., $350. Send for complete stock list. Power Machinery Exchange, Jersey City, N. J. 8-15-2

FOR SALE—Ice and electric light plant in growing town in Southern Illinois. A. C. equipment. Long term franchise and street lighting contract. Railroad icing contracts and a good ice business otherwise. Plant all new. This is a good proposition for a live man. Address No. 489, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 9-1-2

FOR IMMEDIATE SALE — COMPLETE STEAM EQUIPMENT—In excellent condition; from plant now operated electrically. 2—264 H. P. Cahill Horizontal Water Tube Boilers. 1—22x42 Reynolds Corliss Horizontal Engine. 1—24x30 Class "B" High pressure Heavy Duty Slide Valve Engine, made by Houston, Stanwood & Gamble. 1—13x15 Skinner Engine Automatic, Direct Connected to 75 k.w. Generator for 110 volts D. C. Feed Water Heater, Belting, Line Shafting, Live and Exhaust Steam Piping, Steel Shaft Supports and Bearings, Pulleys, etc. Harbison-Walker Refractories Company, Pittsburgh, Pa. 9-1-1

Patent and Patent Attorneys

PATENTS THAT PROTECT AND PAY—Advice and books free. High references. Best results. Promptness assured. Send sketch or model for search. WATSON E. COLEMAN, Patent Lawyer, 624 F St., N. W., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact costs. Send for full information. tf.

A. P. CONNOR, Consulting Electrical and Mechanical Engineer, Attorney-at-Law and Solicitor of Patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf.

PATENTS—Send sketch for free search and reports. Books and patents and book of reference letters sent free. John S. Duffie & Co., 612 F St., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Technical Books

FREE ENGINEER BOOKS and power plant tools and specialties, for securing new subscribers for Power Plant Engineering. A dandy chance for the engineer with a little spare time to get some fine premiums. Send for free descriptive circular and terms. Subscription Department, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill.

Miscellaneous

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes without back pressure on your engine? If so, address Monash Engineering Co., 1413 Jackson Blvd., Chicago, Ill. tf.

Sparks From The Advertising Pages

Gathering Inspiration

Separate yourself from the rest of your profession—from the things that are allied with your work and you'll find yourself failing for want of fresh ideas or you will find that you're on a narrow-gauged track that runs from work-time to bed-time, day after day through a most monotonous and uninteresting land.

That's when the future looks black.

Cease associating with men whose efforts are in the field of power plant engineering—eliminate text books and power plant magazines and engineering literature and you eliminate the factors that stimulate interest and after all the major cause of Success is, Interest. With Interest comes Skill, and Success is their hand-maid.

You must read and read and keep on reading in the literature of your profession if you are to succeed.

Just a line or two or even a single word may start a train of thought that will open new vistas of possibilities right in your line.

Such are the workings of the mind.

The ideas inspired constitute the capital of the brain—you can draw interest on them.

There is hardly an issue of any industrial magazine that does not contain a small mine of information for its constituents. But you must work that mine. Dig and dig until you have uncovered every new thought and new idea.

You'll find them in every section of the magazine. The advertising section contains a variety of thoughts in crystallized form. You can't afford to overlook the smallest advertisement. All should receive your closest attention. Especially is this true of the advertising section of Power Plant Engineering. Manufacturers are urged to change their announcements as often as possible.

Consequently you see the same problem approached from different angles. This has a definite advantage to the constant reader—it broadens him and inspires originality in thinking. Never let a single advertisement escape your attention.